ENGINEERING

An Illustrated Weekly Journal

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GUIDING PURPOSE

It has been a great disappointment to learn that the Eisenhower-Macmillan talks were principally on military matters to the exclusion of the economic and commercial possibilities of Anglo-American co-operation. If the military preparedness of the West is sufficient to act as a deterrent to war, or if it can be brought to that state, then the real threat we must meet is the power of the U.S.S.R. to launch out into world markets with cheaper products, with more engineers and scientists for the under-developed countries, and with capital that will tempt more countries into the Soviet orbit. There is no reason why the same organisational methods which produced the *sputnik* should not be applied successfully to the production of machine tools, electric locomotives, turbo-alternators, instruments, bicycles—in fact, all those products of modern engineering which maintain the solvency of an industrial nation if they are produced at the right price for the overseas markets. Military preparedness depends on the decisions of a comparatively few leaders in Government, the Civil Service and industry. Commercial success—in the Western world at least—depends on the foresight and hard work of everyone who has a sense of responsibility.

One paragraph of the " declaration of common purpose " issued by President Eisenhower and Mr. Macmillan after the meetings referred specifically to the contribution which civil industry can make. " We recognise that our collective security efforts must be supported and reinforced by co-operative economic action. The present offers a challenging opportunity for improvement of trading conditions and the expansion of trade throughout the free world. It is encouraging that plans are developing for a European free trade area in association with the European common market. We recognise that especially in the less developed countries there should be a steady and significant increase in standards of living and economic development." In a more general sense the declaration revealed that " the guiding purpose of our deliberations has been the determination of how best to utilise the moral, intellectual and material strength of our two nations in the performance of our full share of those tasks that will more surely and promptly bring about conditions in which peace can prosper."

The dangers of a sudden Russian supremacy in world trade arise not simply from their technical ability, of which the West has so dramatically become aware. In a letter to *The Times* this week, a group of distinguished Oxford and Cambridge economists show that purely economic factors could precipitate such an unexpected change. " It is not always realised," they say, " that a comparatively small fall in commodity prices [such as has taken place in recent months] is equivalent in its effects to a cut of billions of dollars in aid to under-developed countries. The Western powers must not be surprised if, in the circumstances, such countries turn more and more to Russia as a potential trading partner; and the spectacle of industrial production stagnating in the West while it forges ahead in the East could create an unfortunate impression in those countries not firmly committed to either camp." The United States Government of the United States is by no means blind to the help they can give, particularly to Western Europe, in accelerating the growth of intellectual resources. The Government has indicated its readiness to contribute 500,000 dols. to a joint fund with which a scientific and technical manpower programme, designed to overcome the lack of scientific and technical manpower in Europe, would be established under the auspices of the Organisation for European Economic Co-operation. The Americans are themselves short of scientists and engineers—though it is probably now only a marginal shortage or due to over emphasis on development rather than on basic research—but they believe that there are various ways in which international action can help other countries. They believe that " some permanent institutional arrangement " ought to be developed within the O.E.E.C. to carry out the programme of action.

In the long run this is the kind of initiative which holds out the greatest hope. This is the manner in which, to quote the words of the directive given to the Anglo-American experts, " our two countries can be of greater service to the free world." It is dangerously misleading to think of the U.S.S.R. solely as the opposing party in " an ideological struggle." They have the potential power, even though they are communists, to become serious commercial competitors. If that happens on a large scale, the technical salesmen, the consulting engineers, and all who have to sell our goods and services abroad will have no time to bother about idealogical struggles. The President of the United States and the Prime Minister of Great Britain were bound to put military considerations first—they have immediate and virtually direct control over armaments, whereas they can only influence production, trade and commerce indirectly over a long term. Engineers and businessmen in both countries, however, can help to preserve a sense of proportion by putting their activities first in priority.

Cover Picture. *To produce hydrogen peroxide, a supply of dry air is required. The illustration shows part of the manufacture of an electric heater coil for a dual adsorber dryer unit in which activated alumina is used to remove moisture from the air. Heating re-activates the material by driving off the adsorbed moisture.*

* * *

Plain Words

Engineers are cautious people. If an engineer is working on a revolutionary project he is not easily drawn into a discussion of possibilities and probabilities. He would run a mile rather than submit to the questioning of a reporter from Fleet Street. And if anyone asks him for a sketch of a design which is still in the embryo stage, he shuts up like an oyster. At this point, enter the artist to create an "artist's impression." Very imaginative fellows, these artists.

Dr. Smith, let us suppose, has been given a directive to prepare a preliminary design for an electronic machine which will measure and analyse the intelligence and aptitudes of schoolboys and then feed each of them with the special kind of instruction and questions that he needs to develop his latent powers. Dr. Smith gathers together a team who, between them, can cover the whole field, do the experimental work and develop the design. They work with mounting enthusiasm, protected by strict security measures, for a year. Then one day the publicity chief, who has been growing steadily more impatient, informs the management that a rival firm is believed to be starting work on a similar scheme. The directors therefore decide to issue a guarded statement to the Press, announcing that work has been in hand for a year and that encouraging results have been obtained. The statement is perhaps 500 words in length. Within 24 hours, hundreds of thousands of words have been published on the subject. In the same period Dr. Smith has been coaxed and bullied into writing articles, appearing on television, talking on the radio, answering criticism from the teachers' union and endless questions as to whether he has any children himself, whether he was top or bottom of his class at school, whether he was ever a teacher, whether the machine would be able to administer the cane. . . .

If the truth were known, Dr. Smith is rather pleased about all this publicity. It is hectic and bewildering, but the consequence which upsets him most is the rash of artists' impressions which have appeared in the papers. He has not authorised any of them, he fails to fix the responsibility on any member of his staff, and although the drawings have some degree of practicability they bear little relation to the design study. He wishes now that he had agreed to do the sketch on the back of an envelope which one of the reporters wanted him to do. What a valuable experience the past few days had been. He would never make the same silly mistakes again—a train of thought which brings him back to his machine: Mark II would have to be a machine for imparting experience.

THE ENGINEERING ORIGINS OF TELEVISION

From early days man has sought to move beyond the confines of his limited knowledge and explore the unknown. One particular expression of this was the ever broadening scope of the ancient storyteller, who brought to his listeners the wonders of afar. Television, a natural descendant of the folklore peddler, is the art of observing events as they take place at a distance. In this modern age the viewer at home carries on a world-wide exploration, attends luxury nightclubs and sees the top entertainers, without moving from an armchair; outside broadcasts—some equipment is shown in Fig. 1—possibly provide the most popular entertainment of to-day. The scientist uses television in underwater oceanographic research and to examine processes such as nuclear explosions and for a host of other activities where the presence of human beings would be dangerous.

Reflection upon the fact that Britain was the first country to adopt a public television service, which opened at the Radio Show on August 26, 1936, and commenced regularly on November 2, 1936, is likely to prompt further consideration of the scientific progress that made this event possible. In this brief history of television much will be ignored, for a short article can only deal with the major events, the first of which was the discovery of photo-electricity.

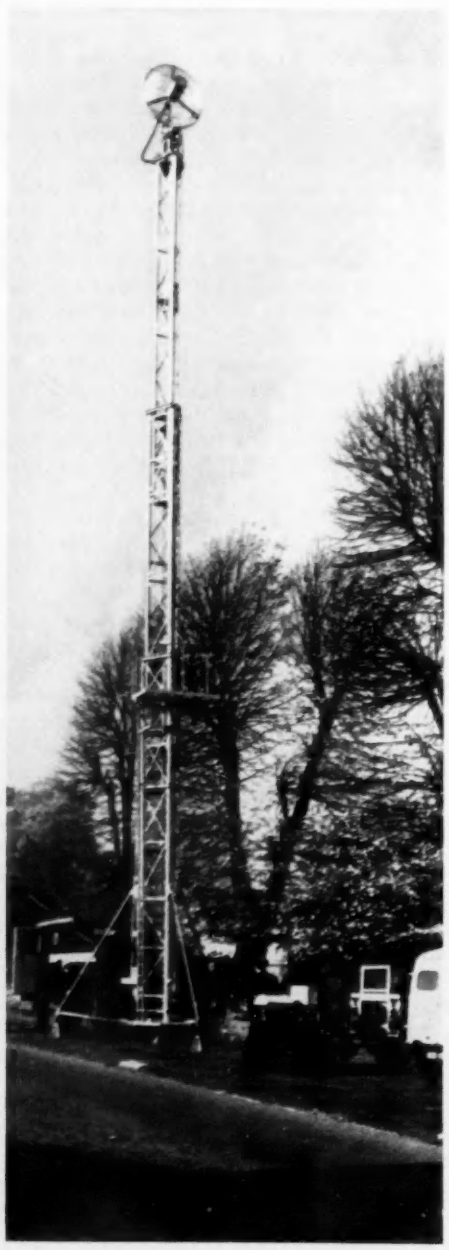

Fig. 1 It is in "outside" broadcasts that television has made its recent advances and has had its greatest impact on the public.

In 1839, Becquerel[1] noticed that certain metal electrodes, immersed in a suitable electrolyte, developed an electrical potential when illuminated and, though this is now only of historical importance, paved the way for considerable research into this phenomena. The first practical observation of the photo-electric effect was reported by a telegraphist named May,[2] who noted that certain resistances changed in value when exposed to light. Subsequent examination showed that these were made of the metal selenium. In the seven years which followed the announcement in 1873 of May's observation, wild speculation on the possibility of transmitting pictures by electricity resulted in many unworkable schemes being put forward.

Amongst others, Ayrton and Perry devised an interesting scheme, details of which were published in 1880.[3] The proposal, as outlined, comprised a transmitter unit, which was to be made up of a large surface of separate selenium cells, each electrically insulated from its neighbour, with cable connection to a receiver unit. Ayrton and Perry suggested two types of receiver, but as they both had the same principle only the simpler system will be described here. Referring to Fig. 2, it will be apparent that light reflected from an object and focused by a lens on to the transmitter selenium squares built up a series of electrical potentials proportional to the illumination falling upon them. The output from each section of the transmitter was connected directly to the receiver screen, composed of a series of electromagnetically deflected shutters, the movement of which limited the degree by which light could fall on to a ground-glass screen. In this manner an observer would be able to see the original scene reproduced at some distance. Due, however, to the fact that definition would have been very poor, and the complexity of wiring costly, the project never materialised, although a later suggestion to use commutators in synchronism and entailing only one pair of connector leads between transmitter and receiver could have been explored.

Probably the most important of the early television systems advanced was that of Nipkow in 1884, as his patent[4] provided the basis for early moving pictures on film as well as of the Baird experiments dating from 1923. Fig. 3, which is copied from Nipkow's patent, shows the practical laboratory arrangement. The image of the scene is focused by the lenses *L* on to a selenium plate *Se*. Interposed in the light path is a disc *D* with a series of holes in spiral form around the perimeter, the pitch of the spiral bearing a direct relationship to the picture width. As the photo-emissive effect of selenium varies in proportion to the illumination falling on it, it follows that, as the disc rotates, the induced current fluctuates. This fluctuating current is fed to the receiver unit, which consists of a flint-glass light cell *LC* surrounded by an electromagnet. The operation of the receiver is best illustrated by noting that the light from an electric arc lamp impinges upon the flint-glass cell, which in turn is modulated by the varying current passing through the coil *Em*. Unfortunately, as selenium is a relatively insensitive material, the Nipkow equipment remained largely a laboratory curiosity until the discovery of thermionic valves by Fleming and De Forrest gave a new impetus to research.

In the quest for more sensitive electrical converters of radiant light two scientists, Elster

and Geitel, discovered that potassium and sodium, and their alloys, when enclosed in vacuum glass cells, possessed properties similar to but more sensitive than selenium.[5] Meanwhile, the cathode ray tube had come into existence, and a member of the Röntgen Society, A. A. Campbell Swinton, saw in this a means of using it as the camera and receiver units of a television system[6].

A little before this, in 1907, a British patent had been granted to Boris Rosing, who had succeeded in obtaining crude pictures on a cathode ray tube receiver. In the course of his presidential address to the Röntgen Society in 1911, Campbell Swinton enlarged upon his concept of a television system. It was proposed that a special type of cathode ray tube, with a built-in screen of photo-electric elements, was to be scanned by a beam of cathode rays magnetically controlled by the current in a special generator. From this type of transmitter, it was postulated, the receiver tube could be fed with photo-electric currents and synchronising information, the latter by means of two coils mounted on the neck of the cathode ray tube. The proposed system was never put into operation, although in concept it was very close to present television systems.

From 1911 to 1923, most research workers in the field of electron-optics devoted energy to producing efficient photo-cells, cathode ray tubes and mirror-drum cameras. The best-known British pioneer, John Logie Baird, became interested in the art of television and picked up at Nipkow's patent, with the additional advantage of having valve amplifiers at his disposal.

The early work of Baird was to a large degree a re-examination of the methods and apparatus of others which, coupled to the later developments of the 1900 to 1920 era, brought results which stimulated fundamental research and public interest. In 1923, when Baird commenced his experiments, he was effectively on his own. However, in April, 1925, he demonstrated crude images transmitted between two machines, and in January, 1926, displayed to members of the Royal Institution moving pictures of faces in the audience. Although these pictures were of very poor definition, the audience could recognise the people concerned. The improvements which followed in rapid succession whetted the appetite of the technical and general public; in May, 1927, television pictures were transmitted from London to Glasgow by telephone line; in February, 1928, pictures went from London to New York by transatlantic radio; in June, 1928, Baird introduced an innovation which permitted the use of daylight for experiments in place of the artificial light used hitherto; and in August, 1928, he demonstrated a means of producing a crude colour television picture[7].

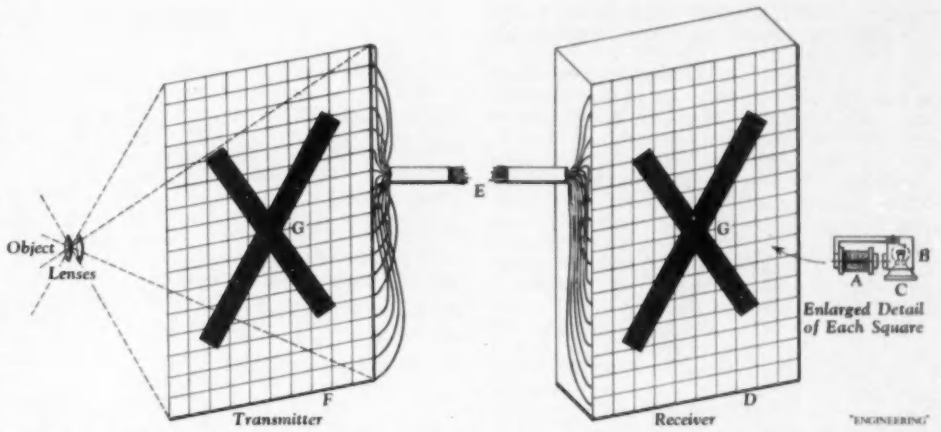

Fig. 2 The Ayrton and Perry scheme—the first working television system. The transmitter and the receiver were cable connected and the picture had only a very low definition.

A Electromagnet. B Shutter Arm. C Lamp. D Ground glass screen. E Connecting cable. F Selenium plate. G Pattern.

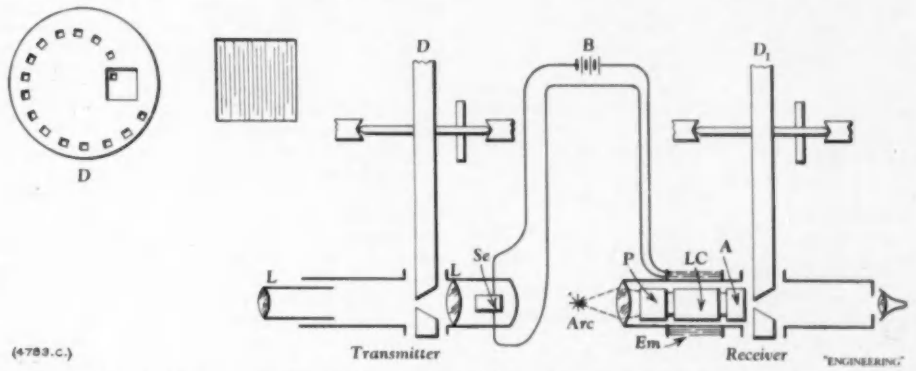

Fig. 3 Nipkow's German patent of 1884, on which Baird's first experiments were based. The use of pulsed transmission gave better picture definition than did Ayrton and Perry's system.

D and D_1 Disc. B Battery. L Lens. Se Selenium cell. P Polarising prism. LC Flint glass light cell. A Analysing prism. Em Electromagnetic field coil. * Arc lamp.

From September, 1929, until August, 1932, the Baird Company and the B.B.C. transmitted experimental television programmes, but from then on, until September, 1935, the B.B.C. took over the sole responsibility for continuing tests on 261 metres, medium wave. The early receivers were Nipkow disc or mirror drum types, the former providing a picture of 4 in. by 2 in., and the latter 9 in. by 4 in.; both forms of receiver were inefficient with a picture resolution of the order of 30 lines per centimetre.

Research in many countries, notably France, Germany, United States, Hungary and Britain, became more devoted to obtaining higher standards of picture resolution. This, in turn, resulted in the individual investigator becoming part of a specialised team sponsored by commercial engineering organisations, with the

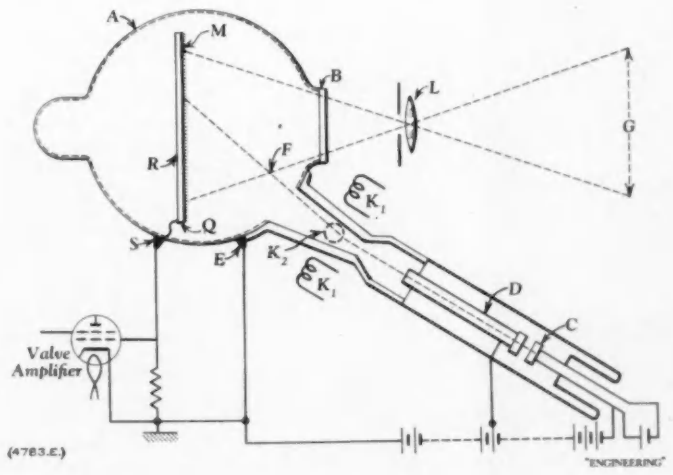

Fig. 4 Components of the Emitron television camera.

A Evacuated glass envelope. B Transparent window. C Cathode. D Focusing electrodes. E Earth contact for internally deposited silver coating. F Electron beam. G Object in focus. K_1 and K_2 Deflection coils. L Lens system. M Mosaic photo-electric screen. Q Insulating sheet. R Signal plate. S Signal plate contact.

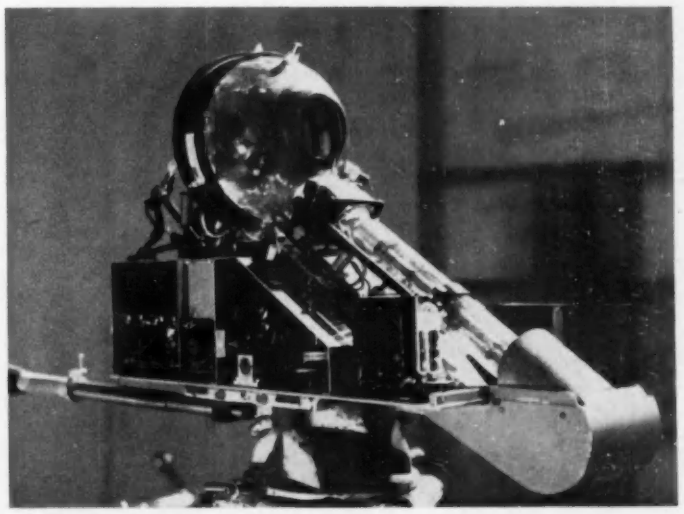

Fig. 5 The Emitron camera.

Figs. 4 and 5 The Emitron camera was the first commercial camera to be used on the public-service high-definition system.

facility to utilise any new development in the photo-electric, thermionic valve, cathode ray and allied fields.

Baird produced an electron camera which provided a picture resolution of 240 lines per centimetre, while the Marconi-E.M.I. Television Company developed a camera to provide 405 lines per centimetre. The relevant studio apparatus was installed at Alexandra Palace, North London, and both systems were transmitted simultaneously in the short-wave band for a trial period. The Television Advisory Committee eventually recommended that the Marconi-E.M.I. system be adopted for a British high-definition standard, and this is still in use to-day. Since 1936, and particularly in the post-1945 period, many countries have adopted public television systems, and though the standards chosen are in every case different from our own the following description of electronic television is common to all.

One of the earliest really successful electronic cameras was developed by E.M.I., the "Emitron." Although now obsolete, this form of camera still provides the best introduction to television principles.

Reference to Fig. 4 shows that the tube consists of an evacuated glass envelope *A* which has a flat-plate mosaic screen *M*, on to which the image of the scene is focused by a lens system *L*. The mosaic is composed of globules of photo-sensitised silver, each electrically separated from its neighbour, and all mounted on a mica insulating sheet *Q*. Backing this is the "signal plate" *R* which is connected to an amplifier valve.

Located in the neck of the tube is an electron gun, which is an electrically heated cathode similar to that of a cathode ray tube or valve. As the electron beam passes through the constricted portion of the neck, it becomes influenced by two magnetic fields generated by coils K_1 and K_2 perpendicular to each other. These provide the scanning rates, which are analogous to the manner in which the eye scans a book, i.e., in a series of horizontal lines.

When light falls upon the mosaic, each globule liberates electrons proportional to the degree of illumination received. As the scene focused on the mosaic provides varying amounts of "free" electrons, some elements receive more light than others. The elements receiving the greatest amount of light will give up most electrons and therefore become positively charged, while those receiving no light will remain unaffected. Between these extremes will fall a number of tonal grades represented by different rates of emission. Effectively the mosaic forms a series of small electrical capacitors with the signal plate; thus it will be appreciated that the electron beam, in restoring each globule to a zero potential, discharges the capacitor and this picture-element pulse is communicated by electrostatic induction to the signal plate *R*, and thence to the valve amplifying system for ultimate feeding to the transmitter. Fig. 5 shows the Emitron camera ready for service and in action. Fig. 7 illustrates a Pye 3 in. image orthicon camera which is currently in use in a B.B.C. studio.

As the electron beam scans along each line and passes over the image of varying brightness, a series of electrical impulses follow one another, varying in amplitude. To clarify the remarks above, Fig. 6 shows the relationship of picture-signal amplitude to scanning.

In order to reproduce correctly the original scene, it is essential that the transmitter and the receiver work in perfect synchronism. To achieve this, the signal corresponding to each line is followed by sharp pulses which "lock" the receiver unit to the transmitter. These "sync" pulses are generated at the transmitter and, in the B.B.C. system, are located below the black-picture level (Fig. 6). Since these signals are in this manner kept apart from the picture information the receiver is able to select them for application to the scanning coils located around the picture cathode ray tube.

It was quickly noted that with high brilliance the picture developed a flicker when scanned

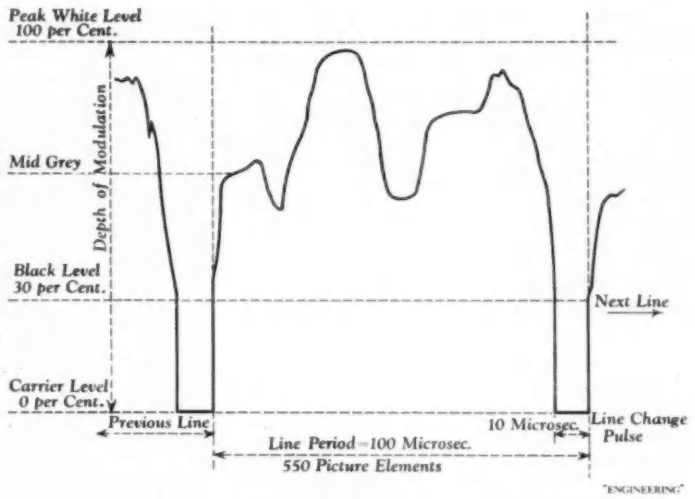

Fig. 6 During the scanning of one line of a picture the electrical output of the camera varies as the light intensity at each point in the line. The "pit" at the end of each line is used to synchronise the receiver scan with that of the transmitter.

at 25 frames per second; this was caused by the retentivity of the eye being of a shorter order than the frame time. The early cinema engineers overcame a similar problem by scanning a film frame twice during the frame period (24 frames per sec.), and this showed the way to the television engineer. The method of overcoming flicker finally adopted uses the principle known as "interlace." The scene to be transmitted is scanned in two movements, the first scan covering lines 1, 3, 5, 7, etc., a space of one line width being left between each line scanned. On completion of the first scan the electron beam returns to the top of the picture and dissects lines 2, 4, 6, 8, etc. The whole picture is thus scanned in two sections separated by one line width, and the eye accepts the flicker-free result.

The basic television receiver has undergone many changes since 1936, notably caused by improved production techniques for valves, components and cathode ray tubes.

After a war-time closure, the B.B.C. Television Service re-opened in June, 1946, and began to extend its range by the establishment of transmitters throughout the country. These now number seventeen, and operate over five channels. In 1955, an Independent Television Service was inaugurated in London, and this now has local transmitters covering the large industrial areas of the Midlands, Lancashire and Yorkshire. During the period of the 1957 Radio Show, the fifth I.T.A. transmitter came into service covering the central Scottish area.

Of historical importance was the opening of a regular electronic colour television service in New York during December, 1953. Throughout

Fig. 7 Pye 3 in. image orthicon type camera now in use at the Kings Theatre, Hammersmith.

the world experiments are continuing to find a cheap and reliable system and, in this country, G.P.O., B.B.C. and commercial interests have followed colour television research with great interest.

In 1956, a study group appointed by the International Radio Consultative Committee (C.C.I.R.) set out on a world tour to examine the various colour television systems being advanced. During the period they stayed in Britain, the committee saw three possible systems demonstrated, and also visited the B.B.C. London Television Transmitter at Crystal Palace which had come into service to replace the old one at Alexandra Palace. Experimental transmissions have also taken place to provide data on the use of television as a school educational medium. I.T.A. began a full schools service earlier this year and the B.B.C. have inaugurated their own this autumn.

To bring the story up to date, the B.B.C., I.T.A. and G.P.O. will continue colour television research with a series of 625 line transmissions on band V. However, it may well be some considerable time before a standard is decided upon. Present black and white television transmits no more than the brightness characteristic of a scene; the complexity involved in radiating colour information has opened up the question of changing our 405 line standard to the 625 lines recommended for Europe by the C.C.I.R. Supporters of this change say that it would open a large export field, and also avoid new problems when transmitting colour pictures on the Eurovision Link.

Television, too, has its faithful spare-time band of engineering devotees who are organised in the Television Society or British Amateur Television Club. These bodies act as clearing houses for ideas and also run their own TV transmitting stations. Within the TV Society and B.A.T.C. there is scope for the individual to study problems several years ahead of "official" schedule. On shoe-string budgets these enthusiasts can occasionally produce results of direct and indirect benefit to the industry. For example, now the emphasis is on uses of ultra high frequency, colour transmission and long-distance networking, the present-day experimenter stands a good chance of adding his name to the annals of television history.

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Companies in the News

Hawkers in Canada

The achievements of the Hawker Siddeley group in Canada were underlined by Sir Roy Dobson, chairman of A. V. Roe, Canada, at the company's first annual meeting as a public company. The recent acquisition of a controlling interest in Dominion Steel and Coal Corporation (DOSCO) fits well into the group's policy of product diversification and commercial balance. It has substantially improved the ratio between commercial and defence business. It has also resulted in the building up from virtually nothing in just over 12 years what Sir Roy Dobson described as " one of the largest single industrial enterprises in the whole Canadian economy." Prior to the acquisition of DOSCO, Hawkers Canadian interests consisted of nine companies which last year had a combined turnover of 235 million dols., of which some 60 per cent. consisted of defence business. If DOSCO's sales are added, the resultant total is in excess of 400 million dols. and the ratio of defence to commercial business falls to 30 per cent. This is a highly satisfactory position, and timely, although even more will be done " to provide a broader industrial base which will further assist the company in playing an important part in Canada's growing economic self-sufficiency."

A year ago the group's main products were aircraft and aircraft engines, railway rolling stock, buses, heavy steel castings and light-alloy products. To these have been added Budd type stainless steel, main-line railway equipment and railcars, Diesel-powered trucks and tractors, refrigeration equipment for the transport industry, and a wide range of electro-mechanical products equipment and systems, automatic computers, flight simulators and specialised motion picture equipment. The object is continued expansion (the group's employment had risen from 300 in 1945 to 20,000 in 1957 without the addition of DOSCO) and reduced dependence on the United States as a source of engineering products.

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More on Diversification

Two leading suppliers to the motor industry, Armstrong Shock Absorbers and Simms Motor Units, have mentioned successful sorties in the industrial markets. Mr. William Armstrong, chairman of A.S.A., reported that the company's Heli-Coil Division had made good progress in finding new applications and had started to make a new type of heli-coil believed to have " considerable scope " in the plastics industry. The recovery in the output of car manufacturers in the past six months has enabled A.S.A. to improve their net profit (after tax) from £81,843 in the year ended June 30, 1956, to £124,319 this year. Mr. Armstrong's optimism " your Board feels that we can look forward to the future with confidence "—will be a welcome tonic for the rest of the industry.

Simms Motor Units also have done well although in their case profits were slightly down despite a record turnover. Their chairman, Mr. Liardet, speaking at the company's annual dinner, announced the addition of two important new products to the company's range, each in the Diesel engine field where they would strengthen further the company's position. One was a turbocharger for which very large demand was expected and the other an inertia starter designed to enable Diesel engine operators to start their engines by hand in a short time with little effort. Outside the Diesel engine field, the major step forward was the acquisition of the Motor and Electronics Corporation. This brings into the group a large new range of products, including electronic components, switches for electrical appliances, for radio, television, radar and the aircraft industry, rotary solenoids and relays for computers and many automation applications, acoustic apparatus, vacuum ware, plastics, railway signalling, transmission joints, and a research laboratory " working on all kinds of electronic projects from guided missiles to control of automobile generators."

Simms' expansion in recent months has been considerable, largely through the acquisition of small manufacturing companies. The recent appointment of a very senior man as chief sales executive suggests that a considerable sales co-ordination problem now exists. A period of consolidation will doubtless follow.

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Change at G.E.C.

After 52 years of service with the General Electric Company Limited, Sir Harry Railing, its chairman and joint managing director, has relinquished his joint responsibilities although he is to remain a member of the board. Mr. Leslie Gamage, vice-chairman and joint managing director, becomes chairman and managing director as from November 1. As an electrical engineer, Sir Harry has been largely responsible for the development of the heavy engineering side of the company's work. He became joint general manager in 1941 and chairman and joint managing director in 1943. In addition to his work for the company he has given much time to work for the Government and for the Institution of Electrical Engineers on whose committees he has served almost continuously for many years. Mr. Gamage is already widely known outside engineering circles for his wide support of the export drive. Like Sir Harry Railing he has given a good deal of his time to advising the Government and to supporting various institutions.

It has been a feature of the heavy electrical industry in this country for some time to have the large groups dominated by one personality. The examples of Lord Chandos and Sir George Nelson come to mind. In the case of G.E.C. it will be noticed that Mr. Gamage combines the functions both of chairman and managing director, a combination not easy for most men to sustain. The heavy electrical industry is fortunate in having men at the top of outstanding ability but the danger should be avoided of setting a tradition of concentration of power on top level decisions which in less able hands may one day achieve concentration at the expense of flexibility and imagination.

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Babcock's at Dalmuir

The transfer to Babcock and Wilcox of the Royal Ordnance Factory at Dalmuir, Dunbartonshire, was the subject of an enlightening statement of policy on the company's part. Emphasising the important part played by the engineering industry in the improvement in the country's standard of living and in exports, they express their belief that " by increasing their manufacturing facilities and diversifying their products, the company will be able to extend their considerable part in this national effort."

The statement is an expression of faith in the future demand for power engineering. Babcocks designed and built the steam-raising units for Calder Hall and Chapel Cross and are actively concerned with the design and construction " of much larger atomic power stations " for the United Kingdom and abroad and are " in the forefront " of developments relating to nuclear ship propulsion. The factory and equipment at Dalmuir will provide a satisfactory basis for expansion, particularly the facilities available for the fabrication and assembly of pressure vessels of all types and mechanical handling equipment. In due course the facilities will be augmented to enable a greater variety of products to be made in the factory. Until this is done its full potential cannot be realised.

The take-over will be gradual. Up to January, 1959, the factory will continue to operate as an R.O.F. and Babcocks will place sub-contract work suitable for existing equipment and staff. During the period of transition " every endeavour will be made to maintain an even load on the factory by feeding in new work as defence contracts taper off." Eventually, more tradesmen will be recruited, new machines installed, and a large new production unit will have been added to the Babcock group.

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Ransome and Marles Bearing

The manufacture of bearings has grown immensely since the war and Ransome and Marles have shared handsomely in this expansion. Over £1 million has been spent on capital projects in the past two years (financed largely by retained profits). Fully depreciated fixed assets amount to £2·5 million and an equal amount has been written off under depreciation of plant, fixtures, etc. With revenue reserve standing at £2·3 million, the company are well placed to forge further ahead. The trading profits this year (ended June 30) were only slightly higher than last year, £1·32 million compared with £1·23 million. Mr. E. W. Senior, their chairman, considers that these results are satisfactory enough if one takes into account the short-time working in the earlier part of the financial year due to the recession in the motor industry. The effect on profit would have been much greater had it not been for " sales efforts in other directions and the closest attention to factory efficiency."

Mr. Senior finds that " forecasting the future against the present economic background presents many difficulties." He makes the familiar point that cost inflation threatens to eliminate profit margins and the company's ability to export against " keen world-wide competition."

Mr. Senior goes on to express the hope that " the credit squeeze will be intensified and that investment will be matched by savings." Provided a firm can survive the short-term impact of the new measures, there is little doubt that Mr. Senior's outlook is the right one.

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Systems Research in Northern Ireland

Some six years ago the chairman and managing director of Short Brothers and Harland Limited, Belfast, Rear Admiral Sir Matthew Slattery, suggested to the Ministry of Supply that Shorts should enter the guided weapons field. The suggestion was, at that time, firmly turned down on the grounds that the company had no suitable design and development team. That official refusal, however, acted as a stimulus and the following year Shorts opened a new factory, at Castlereagh, leased to them by the Ministry of Commerce in Northern Ireland, undertaking to employ some 300 people in precision engineering work, and later that year they did, after all, receive a contract for a guided weapon test vehicle, the vehicle that was displayed on the Ministry's stand at Farnborough this year.

The research and development department of the new division, which started with some 11 engineers under the chief research engineer, was, two years later, expanded to form a research department for the whole company. It was the original small research team, however, who developed the Short general-purpose analogue computer which has subsequently been sold to many rival aircraft firms, Government departments and overseas in Germany, Italy and Scandinavia. Shorts claim, in fact, that they are the largest producers of analogue computers outside the United States.

To-day, the research department has some 90 technical staff, 65 per cent. coming from

Northern Ireland; their principal function is still primarily "systems" engineering—developing automatic control systems for aircraft, missiles and industrial applications, navigational systems, computers and flight simulators. As well as the Systems Group, concerned with the development of overall systems, there is an analytical section, an electromechanical section, an electronics section, and a mechanical section; a small materials laboratory serves the entire department. Recently, a comprehensive new research building, providing laboratory, office, and workshop facilities, has been opened by the Minister of Supply, Mr. Aubrey Jones. This should materially assist the future progress of the department.

Letters to the Editor

EVOLUTION OF SPORTS CARS

SIR, I have read with great interest your leading article "Evolution of Sports Cars" in your issue for October 11. I must admit, however, that I am left in some doubt as to the exact point which you are trying to make.

The tenor of your remarks would appear to be set, at the beginning, by the sentence "A sports car should be able to compete in sporting events with some hope of success," and with this premise I would certainly agree. Since, however, you go on to cite, as commendable examples of a trend, the Chevrolet Corvette, the Ford Thunderbird, the Studebaker Hawk and the Packard Hawk and, from Europe, the Ghia Volkswagen, the Auto Union and the Borgward Isabella, success in sporting events cannot be your sole criterion. Nor can your thoughts be confined to cars of comparatively modest price, since you mention the Mercedes 300SL and the Ferrari 250 Gran Turismo, both in the highest price brackets.

I am, therefore, understandably surprised and disappointed that you make no mention whatsoever of the Aston Martin. Certainly, in its latest production form, the Aston Martin Mark III is not, nor is it intended to be, a front line competition car. It does, however, owe a very great deal to a successful racing background and heritage, and I suggest it offers a better combination of sheer performance with comfort, luggage-carrying capacity, silence, refinement, road-holding and braking, than any of the cars you have mentioned.

You suggest, rightly, that for a modern sports car the rear axle should be located "by some means more precise than the master leaf of a half-elliptic spring." Since its introduction in 1950 the rear suspension of the Aston Martin has been by means of trailing links, coil springs, and a Panhard rod. This has undoubtedly contributed in large measure to the road-holding characteristics which have made the car famous, and it is the more surprising in the circumstances that you should have chosen not to mention it.

Yours faithfully,
J. L. WYER,
Director.

Aston Martin Lagonda Limited,
Hanworth Park,
Middlesex.
October 28, 1957.

VIBRATION-RESISTANT FOUNDATIONS

SIR, In a letter published on page 261 of your issue of August 30, under the heading "Foundations which Vibrate," Dr. A. J. King discusses a paper by the undersigned on "Vibration-Resistant Prestressed Concrete Foundations for Engines and Compressors," which was presented at the recent World Conference on Prestressed Concrete in San Francisco, California. The paper proposes incorporating small curved holes in the concrete mat, so that, if resonance occurs, strands can be post-tensioned through the holes to alter the soil pressure distribution under the foundation and the rigidity characteristics of the mat.

In the first paragraph of Dr. King's letter, a very faithful outline of the paper pertaining to the history of the problem and its existing remedies is presented. In the second paragraph of the letter, reference is made to the paper and the alternative method offered by the undersigned for combating excessive vibrations, to which Dr. King adds his opinion that "it is clear on reflection that the static stresses in the concrete bed and wires constitute a closed system and cannot affect the dynamic stiffness of the soil underneath, except possibly temporarily if the bed bends under this static stress."

Ample evidence to the contrary can be cited. First, the mats for large reciprocating machines, in spite of their thickness, are not vibration-wise sufficiently rigid. Stiffness imparted to these supposedly rigid mats improved very markedly their vibration characteristics, as was shown in the discussion by Mr. P. E. Hall on the article by Mr. W. K. Newcomb on "Principles of Foundation Design for Engines and Compressors," published in the A.S.M.E. Transactions for April, 1951. And post-tensioning will do at least that. Secondly, the dynamic stiffness of the soil-mat system with its resulting natural frequency is definitely affected by static stresses in the soil bed, as has been observed by adding and removing weights from the mat, or by erecting and/or demolishing other structures in the vicinity of the reciprocating machine, which, in turn, caused superimposition of static stresses on the soil at some depth below the mat. Reference to this effect can be found in the discussion by Professor G. P. Tschebotarioff on Mr. Newcomb's paper, as well as in several articles on the subject by Professor Tschebotarioff.

The magnitude and the nature of the problem of vibrations of reciprocating machines cannot make theoretical solutions and laboratory small-scale model experiments authoritative criteria of the validity of the alternate method proposed in the paper under discussion. This is the reason why no experimental verification is given at this time. It will have to be tried on actual full-scale installations—a time-consuming proposition.

Yours very truly,
STANLEY H. FISTEDIS.

Chicago,
Illinois, U.S.A.
October 21, 1957.

STAINLESS STEEL DEVELOPMENT

SIR, I am grateful to Mr. W. H. Wentworth Ping for his amplification (ENGINEERING, October 25, page 520) of my necessarily brief sentence on the discovery of stainless steel. My actual words were "Although austenitic steels were first produced by Hadfield as early as 1882, modern stainless steels trace their ancestry to the work of Brearley and Strauss between 1912 and 1916." I leave the reader to judge the degree of confusion.

Yours faithfully,
JOHN HAWTHORN.

Royal College of Science and Technology,
Department of Food Science,
Glasgow, W.2.
October 22, 1957.

WHEN WE WERE YOUNG

SIR, The Russian publication *Yuni Tekhnik* (Young Technician), to which you referred in Plain Words last week, obviously is produced with an entirely different purpose from that behind the *Meccano Magazine*. It would be interesting to know what is the circulation of the former. I cannot imagine that a similar publication in this country would sell in large numbers; perhaps I should add "unfortunately." While the *M.M.* is not so technical as *Yuni Tekhnik*, I always have a feeling that it is playing a pretty considerable part in the preliminary education of engineers, as well as in attracting to the profession many of those who read it in connection with our products. And its circulation is well over 100,000 a month, so that its influence must be fairly extensive, although it is not designed as an earnest instructor of youth in engineering detail.

Yours faithfully,
F. RILEY,
Editor.

Meccano Magazine,
Liverpool 13.
October 28, 1957.

CONTROL OF MACHINE TOOLS

SIR, Plain Words in ENGINEERING of October 25 and the illustrations of Russian machine tools on pages 522 and 523 of that issue "give one furiously to think."

The machine tool section of the Science Museum shows an early British bevel-gear shaping machine, but there are no up-to-date British bevel-gear cutting machines on the market now. With all the modern talk of "flow line production" and "automation" it is of great interest to see what fine examples of the past still survive, such as the block-making machinery from Portsmouth, designed by Brunel senior and built by Maudslay about 150 years ago.

What has happened to the flow line production idea in the intervening years? The early dates of some of the clock- and watch-making machinery in the same gallery of the Science Museum suggest that one thought: why, with such fine examples so long ago have we allowed ourselves to be overtaken in so many directions? The machine tool is the basis of everything nowadays.

In spite of this, there does not seem to be a single chair of machine tool design at any establishment of university status; and bodies like the Royal Society, the Royal Society of Arts, the university schools of engineering, and even the Department of Scientific and Industrial Research, seem to have done little or nothing to promote the higher development of the machine tool.

Think, for a moment, of the old tools, and the wealth of symbolism and legend that has derived from them, closely woven into the fabric of our lives and permeating our daily thought and speech: the axe, the hammer and the anvil, the chisel and the vice, the sickle and the scythe; and the more domestic tools—the loom, the distaff, and the potter's wheel. These tools were the means by which man was able to survive, to cultivate the arts, and to develop the higher human qualities that go with them. (Although the philosophers of classic Greece despised the industrial arts, the earlier Homeric civilisation had a very fine appreciation of them.)

All this symbolism and meaning is inherited by our modern machine tools, in which craftsmanship and artistry of the highest orders are involved, as well as vision and imagination: look at Leonardo da Vinci's sketches for a start. Why have we classified this activity as unworthy, while accepting others in which the intellectual content and educational value do not come anywhere near it?

A wise man of the past once said "I care not who makes a nation's laws if I can command those who make its songs," or words to that effect. The wise man of the present time might well say: "I care not who makes either of them, so long as I can command and control those who design and make its machine tools."

Yours faithfully,
HUGH CLAUSEN.

17 Harman-drive,
London, N.W.2.
October 25, 1957.

Metals and Materials

"TUBE-IN-STRIP" HEAT-TRANSFER MATERIAL

A new material has now been added to the range of heat-transfer products made by Imperial Chemical Industries Limited, Metals Division, Witton, Birmingham, 6. This is "Tube-in-Strip" which provides a tube or a number of parallel tubes as an integral part of a sheet or a strip of metal. Tube-in-Strip, which is manufactured under licence from Revere Copper and Brass Incorporated, New York, U.S.A., is a single piece of metal; there is no brazing, bonding or adhesive involved. During the casting operation, rods of an inert non-metallic material are incorporated in the slab ingot and the position and dimensions of these rods determine the position and size of the tubes. When the slab is rolled the rods break up into fine powder and elongate with the metal as it increases in length, finishing as a layer of fine powder about 0·001 in. thick within the strip or sheet. The resulting gaps in the rolled material can then be inflated to provide tubes having a wall thickness of half that of the strip. During the inflation most of the fine powder from the inert non-metallic rods is removed. A matter of interest is that the inflation pressure is always in excess of the subsequent functional test pressure. Hence each tube is automatically pressure-tested during inflation. The material is cast in standard widths and before inflation the rolled strip or sheet is slit and cut to length to provide either a single tube or several tubes linked together by a connecting web of metal. Sections of the new material cut across inflated sheet and strip are shown in the illustration reproduced above and indicate what can be accomplished by the new process. On the right is seen a panel of Tube-in-Strip after inflation.

At present the materials employed are commercially-pure aluminium and de-oxidised copper, but the range will be extended to aluminium and copper alloys when the anticipated demand arises. The widths of the copper strips supplied range up to 22 in. and those of aluminium strips up to 26 in. The diameters of the tubes at present are limited to certain dimensions between ¼ in. and 1 in., and the minimum width of web between the tubes to ¼ in., but extensions to these ranges will be made if the need arises. The copper-strip thickness varies from 0·01 in. to 0·125 in. and that of aluminium from 0·02 in. to 0·125 in.

The metal is delivered to the client as sheet or coiled strip, so reducing packing and transport costs, particularly for thin materials where the risk of damage to inflated tubeways would be considerable. Uninflated material is available in lengths of up to 500 ft. depending upon the gauge of the strip required. Normally, the client inflates the material as and when required. The method is relatively simple, requiring only pneumatic or hydraulic pressure and a simple form of coupling. Free inflation results in the formation of a perfectly round tube but if the inflation is carried out under suitable restraining dies, tubeways having other contours can be produced.

The material may be bent, formed or drawn before inflation or manipulated after inflation, as desired. The range of applications of the new material is considered to be wide but it is felt that full benefit from its use will often be possible only by designing the product and production method to take advantage of its properties. Many applications will be in the field of heat transfer and the material could be employed for such purposes as motor-car radiators and heaters, water heaters, industrial heat exchangers, water and milk coolers, architectural panels, evaporators and condensers in refrigerating plant and air-conditioning units, radiators for use in industry, offices and homes, and skirting-board heaters.

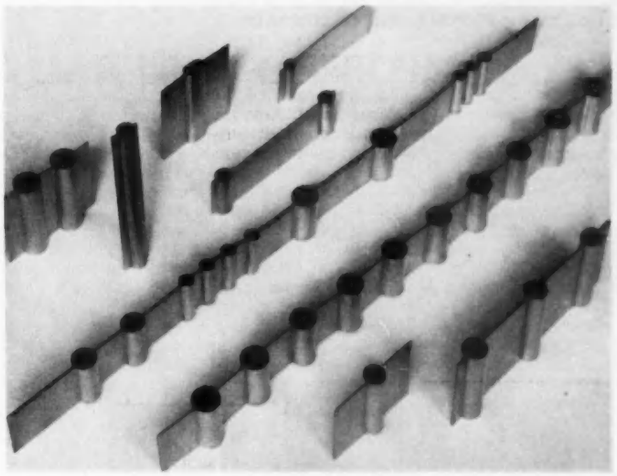


Fig. 1 Sections cut across inflated Tube-in-Strip sheets and panels showing the round tube resulting from free inflation and an oval tube produced with restraining dies.

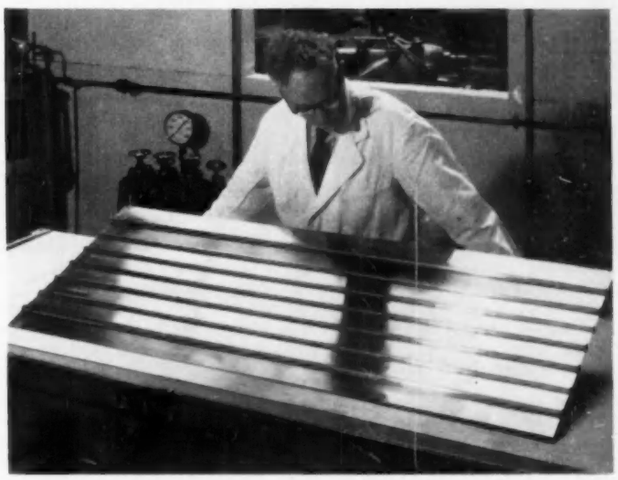


Fig. 2 A panel of Tube-in-Strip material after inflation. The diameters of the tubes at present are limited to dimensions between ¼ in. and 1 in., but extensions will be made if the need arises.

A NEW STAINLESS STEEL

Hardenable and Weldable

A new stainless steel of high tensile strength, which is capable of being welded readily and is remarkable in that it is the only austenitic type of stainless steel hardenable by heat treatment, has been developed by Firth-Vickers Stainless Steels Limited, Staybrite Works, Sheffield, 9. The material, F.V.520, is available in the form of bar, castings, forgings, and sheet and strip. A typical percentage composition is given as: carbon 0·07, chromium 16, nickel 6, copper 1·5, molybdenum 1·5, and titanium 0·3. In addition to high tensile strength and high fatigue resistance, the material, it is stated, possesses stainless properties equivalent to those of the 18 : 8 steels and high resistance to notched impact loads at sub-zero temperatures. It is resistant to stress-corrosion cracking and, as already stated, is weldable, and its thermal expansion is equivalent to that of mild steel. The ceiling service temperature of the new steel is 500 deg. C.

Castings, in the form of centrifugally sand-cast rings, in the heat-treated condition, have given a 0·1 per cent. proof stress of 60 tons per sq. in. (stipulated minimum 50 tons), a maximum stress of 69 tons (minimum 60 tons), and an elongation on 2 in. of 19 per cent. (minimum 10).

Heat-treated centrifugally die-cast rings have given a 0·1 per cent. proof stress of 66 tons per sq. in., a maximum stress of 72 tons and an elongation of 15 per cent. Bars and forgings are usually supplied in the fully heat-treated condition, namely, held for two hours at 750 deg. C., air-cooled to room temperature, and finally maintained for two hours at 560 deg. C. This heat treatment enables the material to meet minima figures for proof stress and tensile strength similar to those stipulated for castings. Coils of strip of Nos. 16 to 28 gauge and up to 1 metre wide are produced in the "air-cooled from 1,050 deg. C." condition. This material is suitable for a number of forming operations and although in this condition the steel has a 0·1 per cent. proof stress not greater than 25 tons per sq. in., it work-hardens rapidly. Formed components may then be hardened by means of heat-treatment cycles somewhat similar to those given to bars and forgings. Sheets of sizes from 10 ft. by 4 ft. down to 6 ft. by 2 ft. are available in various gauges and heat-treated conditions.

It is pointed out that the new steel is suitable for both air-frame and skin purposes in aircraft construction and that it is of value in dealing with problems of the heat barrier encountered by supersonic aircraft and missiles.

Particulars of the new material were given by Mr. John Morley, chief metallurgist of Firth-Vickers, after the showing in London recently of two cinema films entitled: "Where the 'Staybrite' Steels are Made," and "The Manipulation of Corrosion and Heat-Resisting Steels." Both are 16 mm. colour films with sound commentary, each taking about 30 minutes to run, and copies are available on loan, free of charge to technical colleges, institutions and others, on application to the firm at Staybrite Works, Sheffield, 9.

Continuing **Metals and Materials**

IMPORTED NATURAL GAS

Natural gas, transmitted across North America by pipeline, already supplies an important proportion of the total consumption of town gas in the United States and Canada while in France natural gas from St. Marcet is making an important contribution to the fuel supplies of the Bordeaux-Toulouse area and is to be followed by the much larger supplies from Lacq. In this country reserves of natural gas so far discovered are negligible yet if the first trial shipment of liquid gas from Venezuela to this country, announced last month, proves successful, natural gas may make an important contribution to the town gas supplies of this country and have a far-reaching effect on the coal carbonisation industry.

Methane, the principal constituent of natural gas, has about twice the calorific value of coal gas and would require dilution before being fed in to the gas mains. The first load is to be transported across the Atlantic in a 3,500 ton tanker designed to maintain the very low temperature of — 250 deg. F. necessary to keep the gas in liquid form. It is considered that the risks involved in shipping liquid methane are no greater than those of shipping oil. In liquid form the gas occupies only about one-six hundredth of its gaseous volume at atmospheric pressure and it has been estimated that three 30,000 ton tankers making 15 journeys a year could transport enough gas to meet half this country's total gas requirements. It is also considered that imported liquid gas could provide town gas considerably more cheaply than coal gas can be produced here. In addition to Venezuela, liquid gas could also be obtained from the Middle East though transport costs would be higher. Two storage tanks, each of 1,000 tons capacity, are to be built at Canvey Island from which the gas will be fed to Romford gas works where it will be diluted and fed into the mains.

The initial shipments are designed primarily to establish the technical feasibility of supplying natural gas in this way. If successful they will pose a number of problems not least among which will be the availability of solid smokeless fuels needed to supply householders in the increasing number of smokeless zones. If the use of natural gas results in a reduction in the price of town gas relative to other fuels householders may increase their consumption of gas at the expense of solid fuels but even in these labour-saving days the solid fuel fire dies hard.

COPPER STOCKS

It might have been thought that an increase in the Bank rate, in so far as it is an indication of a fear of inflation and devaluation of the pound, would have raised the price of commodities in terms of sterling. This has not happened and copper in particular has continued depressed in price. The spot rate has sagged to a figure below £200 a ton for several weeks in succession.

It is generally agreed that the basic cause of copper's weakness is the availability of mining capacity, the output of which cannot be absorbed by a rising trend of world industrial production for the time being. It is generally thought that it would take a substantial cut in output to restore confidence in copper prices. The intimation, some time ago, by Sir Ronald Prain, Chairman of Rhodesian Selection Trust Limited, that a 10 per cent. cut would be carried out by his own group will probably have a salutary effect if others do the same—especially American producers. So far, however, cuts in output have been somewhat half-hearted.

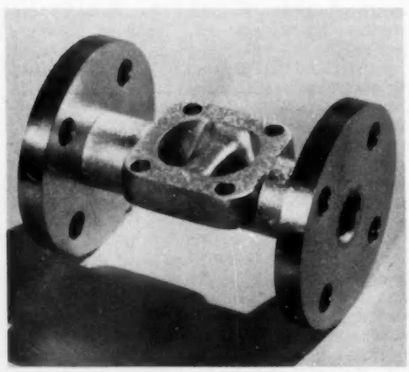
The short-term difficulties in the copper market are underlined by the figures released last week by the Copper Institute and the British Bureau of Non-Ferrous Metal Statistics which showed world stocks of blistered and refined copper at around 1 million tons. Between August, 1956, and August, 1957, world copper stocks have gone up from 710,000 tons to 920,000 tons, that is by nearly 30 per cent. This represents between three and four months' consumption at the current level of activity and, in this country at any rate, users generally carry between three weeks' and a month's requirements. It will therefore take either a sharp cut in output or notable resilience in industrial activity between now and the end of the year to reduce these stocks which are hanging over the market and preventing copper prices from increasing beyond £200 a ton with prospects of a long-term rise.

TITANIUM CASTINGS

The importance of titanium in the aircraft and chemical industries, by reason of its strength, low density and excellent corrosion resistance, is well known, and it is of interest to record that small titanium castings are now being produced—it is claimed for the first time in this country—as a result of a research and development programme initiated by the Metals Division of Imperial Chemical Industries, Limited.

The ability to produce complicated shapes by casting techniques offers obvious advantages, particularly in view of the relatively high first cost of the metal. In the production of titanium castings, certain problems are encountered not normally experienced in foundry work. Melting and casting must be done in a container large enough to allow all operations to be performed out of contact with air. Secondly, molten titanium reacts rapidly with all conventional moulding materials. Further, the gating and feeding arrangements for casting titanium differ from standard methods, as the time available for the molten metal to fill the mould, before solidification, is extremely short. In the technique developed, the operation takes less than ten seconds and results in sound contamination-free castings.

The 1 in. flanged type "A" Saunders valve bodies, as shown in the illustration above, are now being produced in cast titanium in prototype quantities for plant trials. They are made by Imperial Chemical Industries, Limited, Metals Division, in collaboration with the Saunders Valve Company, Limited. Other chemical-plant components, such as impellers and nozzles, are to follow.



One-inch flanged type "A" Saunders valve body in cast titanium, made by I.C.I. Metals Division in collaboration with the Saunders Valve Co., Ltd.

INFLATION AND U.S. STEEL

With the battle against inflation in this country growing in intensity and with an increasing tendency on the part of the Opposition to argue that the only solution lies in price control, it is useful to look at the experience of other countries in handling this problem. In the United States, Mr. Robert C. Tyson, chairman of the United States Steel Corporation Finance Committee, recently testified before the sub-committee on Anti-Trust and Monopoly of the Senate Committee on the Judiciary. He said that if United States steel prices had been fixed at the 1955 level it would only be slightly over a year before profits would be entirely wiped out, together with the taxes paid by the industry. He argued that wage inflation underlies all other cost and price inflation and said that in the experience of United States Steel each dollar of employment cost increase resulted in a two-dollar increase in total costs because of " paralleling wage inflation " of those providing goods and services, plant and equipment.

This argument does not preclude substantial wage increases resulting from improved efficiency of operation. In the case of United States Steel, costs per employment hour were 284 per cent. higher in 1956 than in 1940 but prices of finished steel mill products were only 138 per cent. higher. These price increases, however, had not been sufficient to widen the profit margin which amounted to 9·5 cents per dollar of sales in 1940 when the industry was working at 83 per cent. of capacity, a figure which had never been reached since, and in 1955 the Corporation earned 9 cents on dollar sales when operating at 92 per cent. of capacity.

A further complaint made by Mr. Tyson is also very relevant to this country: that the United States Government failed to recognise in the tax laws relating to depreciation the increasing cost of replacement of plant and equipment. He claimed that, in the case of United States Steel, the depreciation allowed fell short of that necessary for recovery of buying power by 904 million dols. over the 17 year period. The Corporation paid 608 million dols. in extra Federal income tax as a result of treating this deficiency and accelerated depreciation as income for tax purposes.

At a time when a large section of the population is inclined to blame increased profits as the primary cause of inflation, this example of how the profits of a large manufacturing concern may be squeezed by inflation may contain a useful lesson. Mr. Tyson's final warning is also worth noting, that such squeezing of profits if continued as a national policy for industry must result in great unemployment. It brings to mind the 1930's, the last time when the American economy had to operate without profits.

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LOWERING CERAMIC FIRING TEMPERATURES

A factor that limits the production of ceramics for electrical applications is the high temperature at which they have to be fired. Maintaining automatic plant at the necessary temperatures (1,250-1,400 deg. C.) for long periods is expensive both in fuel and in furnace maintenance. A formula conceived by the Royal Radar Establishment, Malvern, attempt to overcome this difficulty.

The ceramic under development has low electrical loss and is thermally stable up to 250 deg. C. It is fired at 900 deg. C. Within certain limits the formula can be varied to produce ceramics with special electrical or physical properties. There is also indication that, in addition to shaping and firing in the traditional manner, hot pressing is possible. Such a technique would make ceramics in close-tolerance patterns available. The pressings would be made from pre-fired and stored blanks.

Plant and Equipment

ELECTRICITY WITHOUT A BREAK

It is often convenient to operate electrical equipment remotely. In Canada, for example, unmanned repeater stations are used in some of the telecommunication links in two of the provinces. Under such conditions it is essential that the power supply at the station be maintained. A similar demand for an uninterrupted power supply exists in hospitals—failure of equipment during an operation cannot be tolerated. In both situations the solution adopted is the use of a stand-by supply and a switching device.

A Diesel electric unit known as RACO (Rapid Automatic Change-Over) has been developed by J. and H. McLaren Limited, Leeds. For telecommunications use, the control gear is designed so that any break in current supply is either less than three millisec. or more than 10 sec. The switching system used can transfer a load from one power source to another with an interruption adjustable down to two millisec.

A control panel is the basic unit. It is a dust-proof, wall mounting cubicle containing all the contactors, relays, etc., necessary to start and stop the generating set when given the necessary impulse from an external source. The cubicle also contains all fault detecting and signalling apparatus for its particular generating set. If the set is on mains stand-by duty, the control panel is energised from a change-over panel that contains the mains-failure detector relays, load transfer contactors, trickle charger, instruments, manual and automatic switches, isolating switch and provision for supervisory and remote radio control. As a further safeguard, the change-over panel can be made to control two sets via control panels. In this case, if one set fails to start on demand, or develops a running fault, the whole sequence of operation is transferred to the second set.

In a station where no mains are available, dual or triple generating sets are installed—each with its own control panel. Two sets are arranged to operate on a basic 72 hour cycle. If a fault occurs on one set, the duty is transferred to the other. In triple installations, a pair of sets normally shares the duty cycle with a third set used permanently as a stand-by. Under fault conditions on either of the duty sets, the operating sequence is automatically diverted to the third set. The cyclic time-switch, change-over contactors, etc., and provision for radio control are accommodated in a timer cubicle.

If a station is equipped with mains, the supply is connected to the load and the set is on stand-by duty. Sets above 6 kW capacity are fitted with a lubricating oil priming pump that operates for approximately three minutes every eight hours. The pump is electrically driven and is isolated from the mains when the set is running.

On failure or 6 per cent. reduction of the mains supply for a period of three seconds, the set automatically starts and supplies the load. The supply contactor is of the change-over pattern, fitted with mechanical and electrical interlocks. When the mains are restored, a process timer is connected in the circuit with a cycle adjustable up to 30 minutes. At the end of the timer-operated cycle, the load will be reconnected to the mains with an interruption to the current supply of approximately 10 millisec. If at any time during the cycle the mains fail and are again restored, the timer automatically resets to its full duration, thus acting as a reference for the regulation and stability of the mains supply source. After the load has been transferred to the mains, the engine runs for a cooling-off period of 5 minutes before shutting down and resetting itself automatically for the next start on demand.

The alternators used on the RACO sets are of the standard Brush square-path type, except that they meet a more stringent specification than is usual for voltage regulation, wave form, and interference suppression. The voltage regulation is maintained within $\pm$ 2½ per cent. of the nominal value for power factors ranging from 0·9 to unity.

Fig. 1 The generating sets are shown undergoing a three day operational test with RACO control equipment.

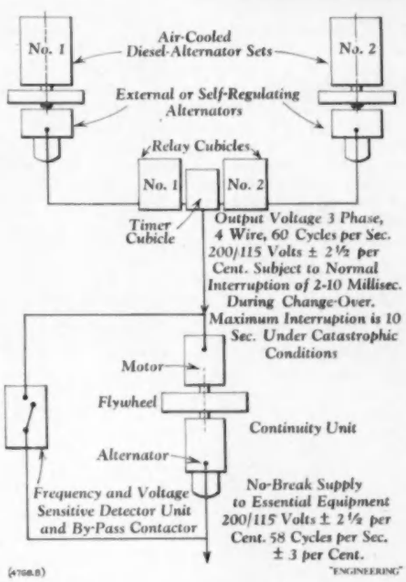

No. 1
Air-Cooled Diesel-Alternator Sets
No. 2
External or Self-Regulating Alternators
Relay Cubicles
No. 1
No. 2
Timer Cubicle
Output Voltage 3 Phase, 4 Wire, 60 Cycles per Sec. 200/115 Volts ± 2½ per Cent. Subject to Normal Interruption of 2-10 Millisec. During Change-Over. Maximum Interruption is 10 Sec. Under Catastrophic Conditions
Motor
Flywheel
Continuity Unit
Alternator
Frequency and Voltage Sensitive Detector Unit and By-Pass Contactor
No-Break Supply to Essential Equipment 200/115 Volts ± 2½ per Cent. 58 Cycles per Sec. ± 3 per Cent.
(4768.8)
"ENGINEERING"

Fig. 2 The RACO system can be converted to a no-break system by the use of a continuity unit. The block diagram shows a typical equipment so adapted.

Air-cooled Diesel engines are used in all cases. Up to 6 kW, the Petter AVA1 or AVA2 type is used. In the range 7·5 to 63 kW, the Petter McLaren PD or PDV engine is used. Special attention is given to the engines in view of the possibility that they may be required to run for periods up to 1,000 hours without any attention. Grease points are eliminated and any grease-packed bearings are capable of operating for at least this period without repacking. Heavy duty air, fuel and lubricating-oil filters must be used and, in most cases, duplicate filters are provided to permit the cleaning of one filter while the other is in operation; so that the engine need not be shut down during the maintenance period. It is also necessary to provide a device for topping-up the sump level: this is done by a spring-mounted supplementary lubricating oil tank. Dry sump lubrication for the PD range is being developed.

Usually electric starting is used. On the smaller Petter AVA types, the alternator incorporates a starting winding, but on all the PD range, a separate electric starter motor operating on the flywheel is used. Development is proceeding on an automatic version of the Berger starter, which may be expected to run up a mains-failure set within 1½ sec. of receiving the starting impulse.

The most economical method of converting the RACO to a no-break system is by using a continuity unit, which consists of an induction motor, heavy flywheel, and alternator; all mounted on a common bed-plate. The motor is of the low-slip type and is normally driven from the mains—or by the duty set in a no-mains station. The alternator is driven through the flywheel and forms a permanent source of supply to the radio equipment and essential services. The flywheel is designed to maintain the nominal frequency to within close limits for a period of ten seconds with the alternator on full load. A diagram of the equipment is shown in Fig. 2.

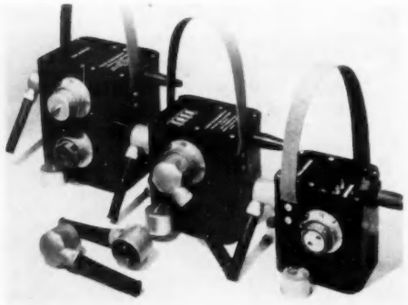
An added advantage is that most other types of no-break sets use a flywheel and magnetic or centrifugal clutch. Such a set must therefore be of sufficient capacity to cover all the services in a power station. Of the total load in the station, however, only a comparatively small proportion is actually an essential no-break requirement. Heaters, ventilators, lights (e.g., for aircraft warning) might without harm be subject to a break of as long as 10 sec. Although, therefore, the requirement for a mains failure or duplicate set in any station may be for example 10 kW, the essential no-break load is probably not greater than 2 kW. Therefore a 2 kW continuity unit can be used with a 10 kW Diesel set, which greatly reduces cost.

With all the safety precautions taken in the continuity unit system, there are still certain instances where very important lines (probably carrying military data) require an even greater factor of safety. For such circumstances the prime source is fed to a continuously rated selenium rectifier equipped with a transistorised voltage-control system that will maintain a float charge voltage within 1 per cent. The rectifier powers a d.c./a.c. rotary invertor, which is the permanent source of a.c. supply to the radio equipment. A 60 cell lead calcium battery is floated across the rotary invertor. In the event of complete prolonged failure of the prime a.c. power source, the battery bank is of sufficient capacity to motor the rotary invertor on full power for a period of 8 hours. Lead calcium batteries were selected because they are able to support continuous float charging for very long periods without damage to the plates and do not require the periodic discharge and recharge cycle customary with lead acid types.

Such power stations operate on the Canadian links in an ambient temperature varying from 40 deg. to 95 deg. F. All stations are unattended, and servicing takes place every two weeks, the battery being the item requiring most attention.

Continuing **Plant and Equipment**

CAST-IN-RESIN TRANSFORMERS



The transformers are cast in polyester resin and are suitable for portable tools. Outputs of 25 and 110 volts are available.

The accompanying illustration shows examples of transformers which have been designed by Foster Transformers, Limited, South Wimbledon, London, S.W.19, for use with portable tools. They are cast in polyester resin and are fitted with a webbing carrying strap. As will be seen, there are two recesses in the top of each unit, one of which contains the primary tapping terminals and the other the secondary fuses. The fuses, which are mounted in clips, comply with British Standards specification No. 1362. Each recess has a gasketed cover. The entry of the primary cable is through a combined rubber bush and tapered sleeve. The secondary connections are made through fuses on each pole, which are mounted on the sides of the unit.

The transformers are produced in three sizes with inputs of 150, 500 and 1,000 volt-amperes at 200 to 250 volts. The output of the smallest size is at 25 volts and of the other two sizes at 110 volts, a 25 volt tapping being provided in addition in each case.

LIGHTWEIGHT SERVO UNITS

A range of servo units, designed to meet the demand for an extremely light, yet accurate power-amplifying device which will provide a displacement output precisely related to an input voltage, has been developed by Harvey Electronics Limited, Farnborough, Hampshire, and is now in production. These British-designed units have already had considerable success in the United States, where they are marketed by Advanced Research Associates, Incorporated, Kensington, Maryland.

The original application of the servo units was the remote radio control of experimental pilotless aircraft. A rapid response was therefore essential, and the transit time of standard units is less than one second.

Each unit consists of a machined cast-magnesium box containing the driving mechanism —a small direct-current electric motor operating a stainless-steel shaft through a train of spur gears. The motor is controlled by a miniature relay with long-life contacts which plugs into one end of the box, and the position of the output shaft is detected by a precision wire-wound potentiometer mounted on the other end of the box. Power and signal information are fed in through a connector mounted alongside the relay. All components are thus readily available for servicing, and provision is made for adjustment of the gears to eliminate backlash.

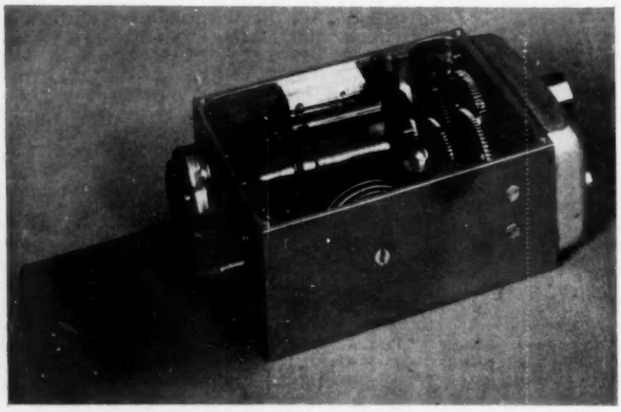
The basic principle is that an error voltage is fed into an amplifier, and the output is applied to the relay. The relay deflects and applies full power to the motor which rotates the output arm in the required direction to eliminate the error. The servo is therefore fundamentally non-linear and full torque is available for a very small displacement error (about 2 per cent. full scale).

Such a simple servo would be unstable and tend to hunt around the null position, so a further oscillating error voltage is generated and fed through the servo amplifier to the relay. For small errors the relay will then oscillate at the " dither " frequency, spending only a fraction of each cycle at the opposite contacts, but the oscillations will be biased by the error voltage so that the algebraic sum of the time spent on the contacts will be proportional to the error, and hence the mean current through the motor will be proportional to the error.

The result is that for small errors the servo unit will behave as a conventional linear servo, and can be stabilised by normal means, thus eliminating hunting, and incidentally reducing the steady power input to the motor to a very low value. As the whole unit is in a state of incipient oscillation, the mean input current to the unit is an accurate measure of the output torque in the steady state.

Performance of the two basic types are summarised below:

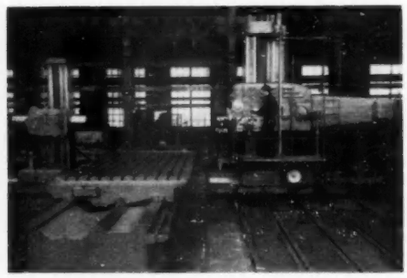
	Type 0	Type 1
Stalled torque ..	1 lb.-ft.	5 lb.-ft.
Maximum speed, no load	60 deg. per sec.	80 deg. per sec.
Input	Plus or minus 6v.	Plus or minus 24v.
Repeatability ..	0·1 per cent. full scale.	0·1 per cent. full scale.
Deflection for full load (90 per cent. stalled torque)	2 per cent. full scale.	2 per cent. full scale.
Deflection	Plus or minus 28 deg.	Plus or minus 28 deg.



The servo unit illustrated here is the smaller of two basic lightweight types designed to give rapid response and a displacement output precisely related to an input voltage.

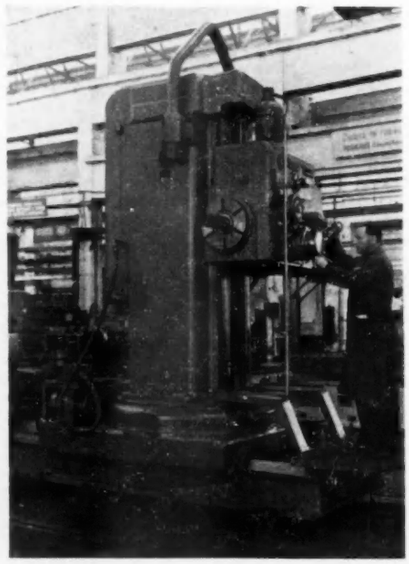
SOVIET PLANT

MACHINE tools in the Soviet Union broadly follow Western practice, though original designs are becoming increasingly numerous. The following illustrations show Soviet boring and milling machines and lathes.



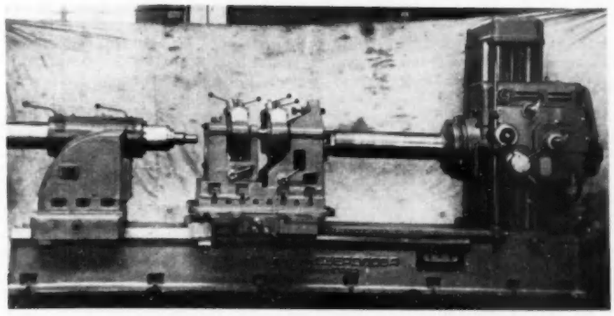
Horizontal boring machine made by the Sverdlov factory, Leningrad, with longitudinally sliding forward head and transverse-sliding table. The table size is 5,000 by 2,500 mm., and the spindle diameter is 150 mm. Remote electrical drive is provided.

Horizontal boring machine, model LP-53 (Sverdlov), a modified version of the model 262D, with multi-spindle head. A high-speed single-spindle version, the model 2621, has a spindle diameter of 85 mm. and maximum spindle speed of 2,000 r.p.m.

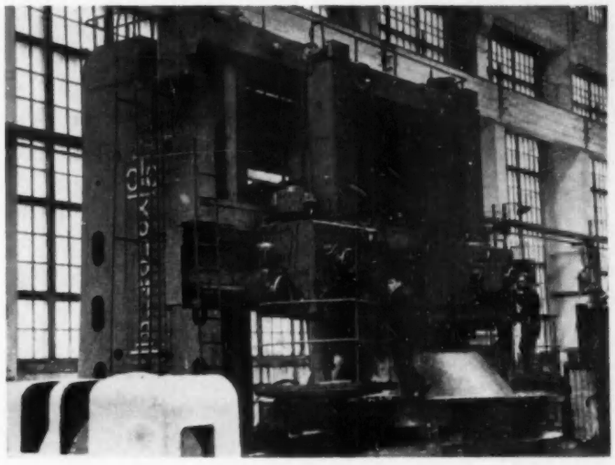


Special-purpose portable boring machine, model LP-44 (Sverdlov), with rotating column. It is designed for machining large heavy items, where it is more convenient to move the tool than the workpiece. The drive is electrical.

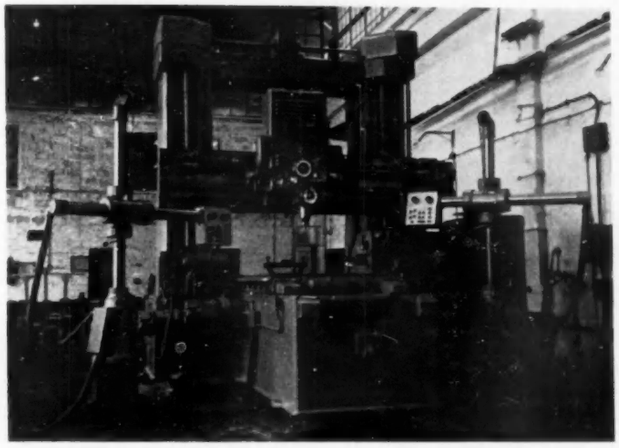
—BORING, MILLING AND TURNING



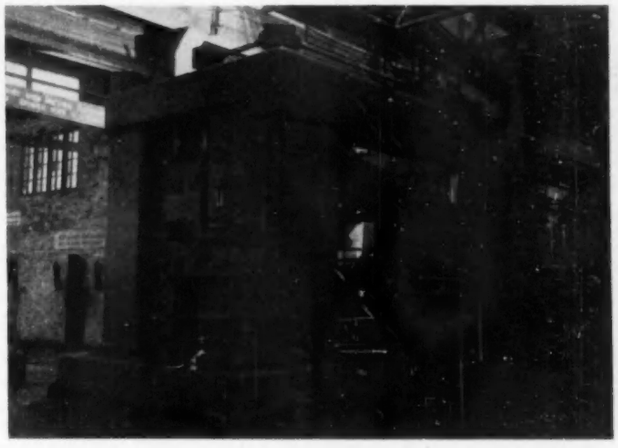
Special-purpose machine, model LP-32 (Sverdlov), for machining the bores of cylinder liners for Diesel-engine cylinder blocks.



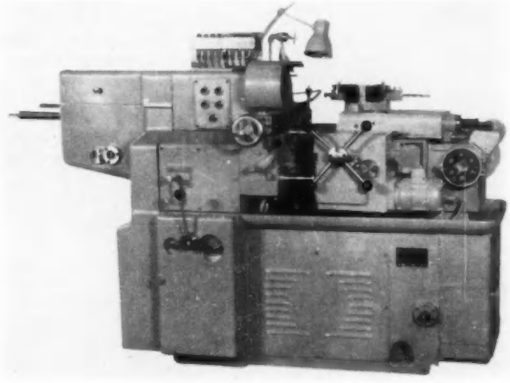
Large vertical boring machine in use at the LMZ turbine factory in Leningrad. A similar machine has been fitted with a table vibrator to give a smooth finishing cut.



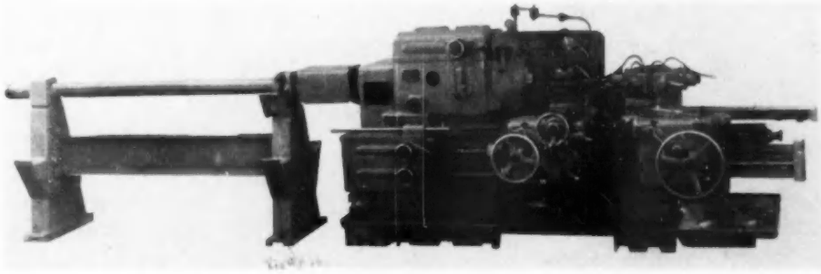
Precision jig boring machine, model LP-87 (Sverdlov). The table is 2,200 by 1,400 mm. in area, and accuracy is stated to be within 2 or 3 microns. Co-ordinate measurements are made with the aid of an optical screen.



Special-purpose copy-milling machine, model LP-16 (Sverdlov), for cutting profiles in large automobile pressings.



Automatic turret lathe, model 1P326 (Enims). The working bar may be up to 25 mm. in diameter and 150 mm. long. Spindle speeds range from 200 to 3,350 r.p.m., and the motor power is 4·5 kW.



Turret lathe, model 1365 (Enims—machine-tool research institute). The maximum diameter of the working bar is 65 mm. and the greatest working length 180 mm. The spindle speed range is 34 to 1,500 r.p.m. and the power of the main motor is 14 kW.

Engineering at Home

LONGEVITY AND ACCIDENTS

The number of fatal home accidents exceeds that of fatal road accidents. Last year there were 7,000 such accidents in the home, an increase of about 1,000 over the number in 1949. Mr. J. E. Simon, Parliamentary Under-Secretary of State, Home Office, has suggested that a preliminary understanding of the increase is to be found by looking more closely at the different causes of home accidents and the distribution of them among the various age groups. Mr. Simon put forward this idea when addressing the National Safety Congress on "Safety in the Home."

In fact, out of the total of about 7,000 accidents, over 5,000 were to people aged 65 and over, and of these nearly 4,000 were 75 and over. A very large proportion of the fatal accidents to old people were caused by falls. It may be, suggested Mr. Simon, that one of the causes of the increase in the number of fatal home accidents is the increasing longevity of the population, which has the effect of bringing an increasing number into the most vulnerable age group.

Referring to the charge that the higher level of home accidents is due to the increasing use of mechanisation and electrification in the home, Mr. Simon said "The fact is, however, that although there has been some slight increase in electrical home accidents—some of which reveal a deep ignorance of elementary precautions—this has been nowhere near proportionate to the astronomical increase in the number of appliances in homes and the quantity of electricity consumed. This achievement is a credit to industry." In the remainder of the address the value of the work by the B.S.I. in drawing up standards for fireguards was emphasised. But Mr. Simon felt that too many people were prepared to accept the view that "accidents will occur in the best regulated families."

CAMPAIGNING FOR OIL

Recent market research studies have led the technical sales department of Esso Petroleum Company, Limited, to the conclusion that many architects, builders and heating engineers, as well as the general public, do not appreciate the advantages of oil-fired central heating for homes.

The advantages claimed are those of: controlled temperature throughout the house, simplicity in operation and maintenance, and the improvement in overall cleanliness in comparison with solid fuels. These virtues are also shared by gas and electricity, but the sales department claim that oil is more economic and although the actual fuel costs of the oil installation are now in some cases higher than coke or coal costs, those of the latter are tending to rise at a greater rate.

To familiarise the building industry with the possibilities of oil fuel for the home, therefore, Esso are increasing the activities of their consulting home heating service, branches of which are established in London, Sutton Coldfield, Manchester, Bristol, Glasgow, and Belfast; and they have recently opened a permanent exhibition of oil-fired central heating and hot-water systems at the headquarters of the technical sales department—87 Albert-embankment, London, S.E.11. The exhibition is intended for heating engineers, architects and builders; it is not designed for public viewing, but anyone particularly interested will be welcome if they will first make application to the company to visit the exhibition.

The exhibition provides a wide representation of modern oil-fired hot-water boilers and whole-house warm-air units. Moreover, there are a number of small units for converting existing solid-fuel boilers to oil-firing. Other exhibits include oil burners and electronic control equipment, baseboard radiation elements and other radiators, and examples of current methods of insulation—a factor of prime importance in keeping down operating costs of domestic as well as of industrial installations.

WASHING AND SPINNING

Washing, rinsing, and spin drying are carried out in the Hoovermatic. The machine combines a washing machine and spin dryer in one cabinet. It is manufactured by Hoover (Washing Machines) Limited, Merthyr Tydfil, Glamorganshire. In 10 minutes 6 lb. of clothes are washed and ready either for ironing or, if the fabrics are heavy, for quick drying on a line. Subsequent loads average 8 minutes, as spinning and washing can take place at the same time. A pre-set timer stops washing automatically.

In the illustration, the two sections of the machine can be seen. The washing section, on the left, is basically a standard product. Eight-and-a-half gallons of water fill the stainless steel tub. The water is heated by a 3 kW immersion heater at the bottom of the tub, behind a grille. When the desired water temperature is reached the switch on the front of the machine must be turned from "heater" to "motor." Setting the required washing time on the timer dial starts the washing. When the timer dial returns to zero the machine is automatically switched off. During washing an inner splash-proof anodised aluminium lid covers the tub. A protective device prevents the heater functioning with no water in the tub.

The spin dryer rotates at up to 2,000 r.p.m. Closing the lid operates a switch and sets the spin dryer running. Opening the lid switches off the motor and applies a brake that stops the rotating container—made of Alocrom finished aluminium. As the container rotates, suds and hot water are spun out and can be returned to the washing machine by an automatic pump via a built-in swivel hose. Fresh water is run in from the tap for one or two quick rinses. This water is pump-emptied into the sink.

The Hoovermatic exterior measures 29½ in. long by 31½ in. high by 17 in. deep. It has an aluminium table top lid, not shown in the illustration. A 500 watt shaded-pole motor drives the washing machine and its pump. The spin dryer and its pump are driven by a 240 watt series-wound motor, suppressed against radio and television interference in accordance with B.S. 800.

A washing machine and spin dryer are combined in one cabinet. Each unit has a separate motor and pump.

STANDARD FOR BUTANE HEATERS

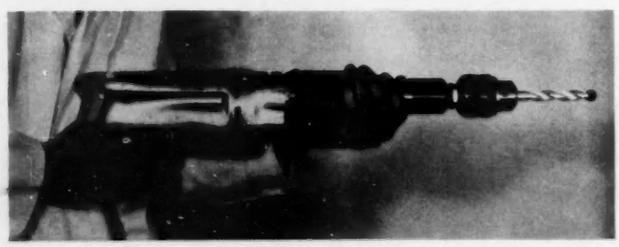
With the increasing use of butane and propane heaters in caravans, boats, and rural locations has come the need for a "standard" product. A British Standard has recently been published, B.S.2883: Part 1, *Water heaters for use with butane gas*, and a heater conforming to this standard has to meet miniumum standards of construction, performance, and safety. The specification includes a test to determine the scratch resistance of the paintwork; and one clause lays down that there shall be no appreciable change of colour of any part of the appliance after operating for 200 hours under given conditions. The heater must be easy to clean and maintain and there are requirements for heat output, ignition and resistance to draughts.

PERCUSSION HEAD FOR DRILL

A new two-speed drill manufactured by Hahn and Kolb of Germany is now available in Britain. An optional accessory that can be clamped on the head of the tool, shown in the illustration, converts it into a hammer drill—giving 9,000 impacts per minute—for making holes in tiles, concrete, and brick. The drill, marketed under the trade name "Duax," is distributed by Trend Industrial Equipment, Limited, Stanmore, Middlesex.

Normally, the drilling of hard stone requires considerable pressure by the operator to obtain "bite" into the material. The distributing company claim that the percussion head increases the speed of drilling by 70 per cent. and reduces operator fatigue. Incorporated in the attachment is a 3-jaw Jacobs type chuck. A button control enables the operator to stop and start the percussion movement at will.

Two models are available. The largest, ZL13, weighs 6 lb. and operates at 560 and 1,440 r.p.m. Its drilling capacity in steel is ½ in., in wood it is ¾ in., and in stone (with the percussion head) it is ⅜ in. The power rating is 200 watts. The other model, ZL8, consumes 120 watts and operates at 630 and 1,900 r.p.m.



The two-speed drill can be fitted with a percussion head to convert it into a hammer drill for making holes in stone.

Management

Weekly Survey

The Might of Research

Very high expenditure on research nowadays is the prerogative of Government or the hallmark of the very large company. Usually, as is the case with aircraft, titanium, nuclear engines—to name only a few of the better known of the major fields of research—the cost is spread over the firm's total activities, whether or not assistance is being given from public funds. It is argued that the lack of competition does not prevent research, but on the contrary that relative security stimulates it.

The report of Thomas Hedley, the British member of the Procter and Gamble international group of companies, with soap and detergent factories in Newcastle-upon-Tyne and Liverpool, have interesting things to say about research. They employ some 300 scientists and their assistants and spent nearly £¾ million on it in the year ended June 30. In addition over £½ million was spent on new research buildings at Longbenton. Practically the whole of the preamble to the directors' statement in the annual report circulated to shareholders is concerned with the type of research work they have to do to keep abreast of developments in their field, including consumer research. This, in spite of a close link and free interchange of information with Procter and Gamble in the United States.

The opening paragraph of the directors' statement is worth quoting in full: "Keenly competitive conditions continue in our industry. These have the effect of stimulating constant scrutiny of all our operations with the object of holding down costs—particularly in buying, manufacturing and distribution—while maintaining improvement in product quality and the development of new products. Quite apart from the stimulus given by competition these aims must, of course, be basic to a progressive company with a proper sense of obligation to the public." In this case the pressure of competition does not appear to have diminished the sums which are spent on research; last year they exceeded trading profits by nearly £¼ million.

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Faster Computing Needed

Recently, when giving a talk to the British Scientific Instrument Research Association, Sir John Cockcroft, Director of Atomic Energy Research Establishment, Harwell, stressed the need for the development of faster digital computers. "We now have the Ferranti Mercury computer coming into use, but four years from now we will want much faster computers capable of dealing with three variables and doing unit operations in a microsecond with a store of 100,000 pieces of information. The United States are developing the Stretch computer as a successor to the I.B.M. 704. We have to hire 704s at about £250,000 per annum. To hire a Stretch may cost a million pounds per annum. I hope this country will put more effort into this field which is going to be of great importance not only to nuclear computing but to many other fields of activity. For this development and many others we require the development of fast transistors with associated fast stores. Microsecond operation is required."

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Challenge and Opportunity

The proposer of the toast to engineering and shipbuilding at the James Watt dinner held at the Saint Andrew's Hall in Glasgow, was the Right Honourable J. S. Maclay, C.B.E., B.A., Secretary of State for Scotland. It was natural that Mr. Maclay should recall the part Glasgow had played in James Watt's career, and that he should follow it with the influence that Watt himself had on engineering and shipbuilding. This led him to speak of the extended Government training schemes and to appeal for the employment of more engineers in shipbuilding, where, at the moment, the numbers were of the order of one-half of one per cent. Most of the money had already been spent on buildings for the new training colleges.

Production of lighter industries had grown in Scotland as a welcome balance to the heavy industries that had been traditional. He warned the industry that although the order book now stood at about four years, the world would not wait while domestic disputes held up progress. Previously the Clyde had been worried by the shortage of steel, but with the proposed production in 1961 of three million tons per annum, the industries felt reassured. The coming Free Trade Area offered an opportunity for industry to go forward and was not necessarily a menace. The Common Market proposals as laid down were designed to meet various difficulties arising between the countries. The time was undoubtedly one of challenge and opportunity for engineers.

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German Industry Invests Abroad

One of the cures urged for Germany's chronic trade surplus is more investment by industrial companies overseas. How much in fact is German industry branching out? The annual export of capital is about £50 million. This is about one-quarter of the British rate and only a fraction of the American. It represents about 10 to 12 per cent. of Germany's annual surplus on trade and services. The biggest amounts are invested in S. America—£44 million, Canada £19 million, United States £15 million, French Central Africa £8 million, India £6 million, and Australia £1 million. Much the biggest investments have been in Brazil which has attracted leading German companies including Siemens, A.E.G., Mannesmann, Bayer, Volkswagen, Hoechst, Bosch and Mercedes. Industries vary from the Mannesmann tube-making works and the 8½ million dol. plant for heavy engineering equipment built by Siemens down to a 4711 Eau de Cologne factory.

Mannesmann is also in the lead in Canada where it has a 14 per cent. share in the Algoma Steel Corporation. A Ruhr consortium is collaborating with an American company in a big ore-mining project in Labrador. Another partnership is the Edmonton steelworks in which Phoenix-Rheinrohr has a half share. After Mannesmann the biggest overseas investors are the Bayer Chemical combine and Siemens. When the Common Market opens, Germany will be contributing 200 million dols. a year to the Colonial Development Fund set up under the Rome Treaty. Most of this will find its way into the French colonies. Even so, with reserves at the present levels, there will be plenty left for further investment abroad without imposing any undue strain on the German mark.

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Negotiating the Free Trade Area

Some interesting points were made by Sir Edgar Cohen, a second secretary at the Board of Trade, speaking to the Cotton Board Conference last week on negotiating problems for the Free Trade Area. It is rarely that the higher civil service has the opportunity to comment on these kinds of topics although they alone have first-hand continuous experience. In the flood of generalisations and comment on the Free Trade Area it is worthwhile to bear in mind some of Sir Edgar's main points. They show the way in which the Government is likely to be thinking during the critical autumn and winter negotiations on the Free Trade Area which lie ahead.

Sir Edgar made it clear that this country wants a much more precise time schedule on tariff disarmament than is set out in the Treaty of Rome for the European Common Market. Under that Treaty, it will be recalled, the process of tariff disarmament is to begin at the beginning of 1959 and to be spread over a 12 to 15 year period. The early timing and degree of disarmament are fairly categorically stated but the whole matter tails off without being worked out for the closing stages—rather like the mouse's tale in "Alice in Wonderland." The British Government are likely to want a definite programme throughout the period of disarmament laid down at the beginning. This country is also going to insist on "fair trade" reservations so that there is no danger of full employment being endangered by a whole industry being put out of business by indiscriminate price cutting from the Continent. The United Kingdom also wishes to have a free hand on the harmonisation of wages. This point is most important for it is one on which the trade unions will insist before any Free Trade Area scheme can be made workable in this country.

It is apparent therefore that two of the main sources of apprehension in this country, "fair trade" practices and harmonisation of wages, are to play an important part in the formulation of this country's negotiating tactics on the Free Trade Area.

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Road Versus Rail

Since the war Government policy on cuts in capital investment have had a certain flavour of the South Sea Bubble of the early Eighteenth Century—there are to be certain developments the nature of which will be divulged in due course. Over the last ten years it has always been exceedingly difficult to tell from official pronouncements just how big cuts in capital investment were going to be. To date, the ones hinted at by the Chancellor of the Exchequer when Bank rate was raised last month are running true to form. The general opinion is that the level of investment in terms of value will be held steady, which means a cut in investment in terms of volume owing to the continuing rise in prices.

The Prime Minister announced when he opened the London Motor Show that plans for new roads were to go ahead. This was not a very precise statement and there is plenty of room for manoeuvre by the Government if they wish to have second thoughts. Ostensibly, however, it would appear that the recent improved priority position of the roads is not to be disturbed. They may not get as much money for development as had been hoped, but they will not be at the bottom of the list—a position they held for about eight years after the war.

Substantial cuts may yet be announced in the £1,200 million railway modernisation scheme. The Government's request for cuts has reached the British Transport Commission at an awkward time. It is known that revised estimates (which means higher estimates) are being formulated for the electrification side of the scheme and for the plan as a whole orders are now building up to a peak. It may be that these orders cannot be cut and therefore the full impact of any economies will either not be achieved or will fall with particular force on certain aspects of the modernisation scheme which might seriously throw it out of balance. Inevitably, there is a flavour of road versus rail in the global exercise of cutting back public investment expenditure. How far the railways may have to suffer for the benefit of a modest road development programme can only be seen when economy measures are announced.

Marketing

MOTIVATION RESEARCH

An American recently visited this country to introduce a new method, motivation research, of finding out what people want and what makes them choose a particular product from a number of available makes. As its name implies, it is a study of motives, just as operational research is a study of operations, i.e. movement and flow. M.R. is being described as being " simply the application of psychological techniques to the study of buying habits."

The methods used are, basically, observation and " depth " interview. A sample of users of the product in question are observed looking at a refrigerator or a car, or a new type of lathe. They are observed looking at advertisements for these things, reacting to displays in shops or showrooms or simply passing in the street. Films (taken through concealed cameras) are used to record their reactions.

The " depth interview " is a method, like psycho-analysis, of letting the subject—in this case the user or potential buyer of a product—talk freely without answering direct questions. It is intended to reveal what lies behind, or beneath, the conscious level of rational answers. This " technique " is applied to the manufacturer of the goods. He is encouraged to talk about his background, his current situation, his problems and successes. An investigation is made of all the factors which have led, up to the time of the interview, to the competitive standing of the product concerned and of its makers.

But there is more than this in M.R. It is a technique to ascertain the precise needs which a product meets and to define these accurately in terms of appearance, performance, etc. It is a means of finding how the user actually *uses* the product in a " real life situation." What does, in fact, make a buyer, chief engineer or plant engineer choose a particular hydraulic press or machine tool from the large number of makes available—often all of closely similar performances? Is it price, or service, or tradition, or his friendship with the sales engineer, or just something he knows very little about but feels strongly? Is it advertising in trade journals or on the screen, or prestige advertising in the daily papers? When these questions are answered the sales promotion department can be set to work.

Observation techniques have long been established in this country for testing people's reactions—by Tom Harrison as early as 1936 when his mass observation studied the reaction of people to the abdication of King Edward VIII. The unprompted, lengthy interview has been used for many years by marketing consultants even in the capital goods field. Engineering Information Service relies on it almost entirely in carrying out market surveys, whether the product be electric motors, titanium-clad steel or motor cars. But, as is their habit, the Americans have given it a new name and a " theory " with a sales appeal. From now on it will be *the* method of carrying out market research. They and those who follow them will educate industry in its use. The phenomenal success so far of those products—including many engineering ones—which were re-designed in accordance with the results of an M.R. survey suggest that not much time will elapse before the whole of industry will either be forced to copy what products have been developed in that manner or carry out similar research.

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New Product Policy

A constant search for something new to make is not a symptom of technical bankruptcy—on the contrary it is those firms who do this most persistently and energetically who appear to come to the top of their industries. Two spring to mind who have recently published their annual accounts: the Dowty Group and Carrier Engineering. Both have immensely increased in size and established themselves as leaders.

Dowty were originally makers of hydraulic aircraft accessories, mainly under-carriages designed by George Dowty, now Sir George, before the war. Ten years ago they were selling 94 per cent. of all they made to the aircraft industry; to-day this proportion has fallen to 40 per cent. and the company have established themselves as hydraulic engineers with a large turnover in mining equipment, hydraulic railway buffers, hydraulic handling equipment for nuclear reactors and many other industrial applications.

Carrier Engineering were originally specialists in industrial heating and air-conditioning. They have now developed into suppliers of " mechanical automation," including automatic paint spray plants and mechanical systems of all kinds. An old-established firm of forgers, Walter Somers of Halesowen, have developed a range of mechanical handling equipment from the automatic handling tongs they designed for their own use in handling heavy forgings. Lee Guiness, who are precision engineers in Newtownards, near Belfast have just acquired manufacturing licences for switchgear from ASEA and Voigt Haeffner. This is a relentless process, which no company can escape.

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Marconi in South America

The recent successes of Marconi in Latin-America suggest that these markets hold high rewards for the enterprising British manufacturer. The currency difficulties of many of the countries are well known, and may have acted as a deterrent. But they are no such obstacles in the case of Venezuela, where Marconi have sold one complete Band III television and one medium-frequency sound broadcasting transmitter.

Other orders obtained by Marconi in South America include a £1 million contract in Ecuador for a telecommunications system, a high-power broadcasting system in Argentina and several other contracts in Venezuela for radio, R/T and another television station. Such performance should be a tonic to the engineering industry.

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Viennese Experience

The activities of the Birmingham Exchange and Engineering Centre stamp this organisation as one of the most useful of those servicing the engineering industry. Quite apart from their specific activities, such as the coverage of the Vienna Fair discussed below, they provide, near New Street station, facilities for the visiting engineer—which includes a telephone service, a typing pool and the taking of messages—quite unique in the industry.

The Engineering Centre's activities at the Vienna International Autumn Trade Fair have yielded useful information on the Austrian market for engineering products. They had a stand adjacent to that of the Board of Trade and conducted an enquiry service and distributed the trade leaflets and catalogues of their members. Their main object was " to encourage enquiries for British products by giving authoritative information on the spot and by facilitating the contact between the engineer and the appropriate British manufacturer." That they achieved this is clear from the nature and number of enquiries received.

The October issue of the Engineering Centre's news letter (No. 33) contains a special report on the Vienna Fair, including a list of agencies wanted by Austrian importers. One of their conclusions is that " there is undoubtedly a market in Austria for most British products and their quality is respected," together with their remark on the strong pro-British feeling they found there, are a good omen for the future liberalisation of trade between the two countries.

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Rustons in Araby

An outspoken criticism of the British government's policy in respect of Syria and the rest of the Arab world was made by Mr. George Anselm, who is a sales executive with Ruston and Hornsby. He returns from a tour of the Middle East with a distressing story of mounting political prejudice against Britain, lack of confidence in Sterling and of floods of exports from Communist countries at what he terms " political " prices. In short Western policy is making life very difficult for the British exporter.

Rustons have a long tradition of exports to this area, and have a knowledge of it probably more intimate than most engineering firms. Their engines, both horizontal and vertical, are widely used in irrigation as indeed are their pumps. The trans-Iranian pipeline is almost entirely Ruston-powered, the municipal and power stations in Latakia, Syria—which are now being completed—will employ Ruston engines. Twenty of their T.A. gas turbines are in use in the oilfields.

Mr. Anselm spoke with influential figures in commercial and political circles. In Syria he found a strong preference for British engineering products but a scarcity of Sterling resulting from the severance of political relations and a readiness to extend very long-term credit by the West Germans as well as the Russians and their allies. In Jordan he found the same plus an expectation of devaluation of Sterling. Mr. Anselm stresses the urgent need for British business interests " to assert themselves in the Middle East, put aside all political prejudice and form realistic views." With the exception of a small minority, he said, the Arabs are still eager to do business with us and be our friends but we must recognise that they can get nearly all they want from behind the iron curtain. It is more than ever necessary to maintain close personal touch and to take business relationships out of politics, whether in the Middle East or the Far East.

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Dealership in Diesels

Traditionally, selling Diesel engines, whether for automotive, marine or industrial applications, has been the job of the manufacturer. Rolls-Royce have broken new ground therefore in appointing Jack Olding and Company as their official dealer in the United Kingdom. Oldings are a subsidiary of Vickers and have for the past seven years sold and serviced the Vickers VR 180 tractor, now known as the VIGOR, which is powered by the Rolls-Royce C.6 Diesel. They have therefore acquired experience in maintaining and overhauling complex equipment and have become expert in the procedures laid down by Rolls-Royce.

Oldings now become mainly concerned with capital plant. Recently they sold their main dealership of Rolls-Royce cars to Jack Barclay. They have service depots at Wolverhampton, Cardiff, Liverpool, Newcastle-upon-Tyne, an associated company at Coupar Angus, and their main offices and works at Hatfield. With competition now developing from Cummins and other American firms the outcome of this move by Rolls-Royce will be watched with interest by other manufacturers. It is a leaf out of the American textbook, in a field where prompt and efficient after sales service is the main competitive weapon.

Research and Development

EXTRACTING THORIUM FROM ITS ORE

Chemical Research at Teddington

In the radiochemistry section of the Chemical Research Laboratory, Teddington, a process for the recovery of thorium from monazite, using phosphorylated cellulose, has been developed. It is explained that cellulose may be phosphorylated by reaction with urea and phosphoric acid to give a cation-exchange material which is fibrous, hydrophilic and possesses a high rate of reaction. The monazite ore is leached with hot, concentrated sulphuric acid and, after dilution and filtration, the liquor is passed through a column of phosphorylated cellulose. Some 90 per cent. of the thorium dioxide contained in the original ore is finally recovered in the process.

Another new development in the radiochemistry section is an ion-exchange resin membrane process for the recovery of uranium from ore leach pulp. Ion-exchange resins are also employed for the recovery of gold, silver and nickel from sodium cyanide liquors.

The work of the Laboratory, which is part of the Department of Scientific and Industrial Research, is carried out by seven research groups. The first is concerned with the corrosion of metals. The second, the inorganic group, has as its main objectives the recovery of valuable constituents from wastes, and the separation and purification of some of the less common elements. The third, the microbiology group, conducts research into the use of bacteria in industry. The fourth group deals with the isolation, purification and properties of industrially important organic materials, and the fifth devotes its attention to the utilisation, purification and properties of high polymers. The sixth group is concerned with radiochemistry and conducts research on the extraction, concentration and analysis of valuable metals from minerals, ores and other products. The seventh group carries out fundamental studies on selected chemical-engineering problems.

Many of the researches in progress were on display during the open days, held at the Laboratory in the first week of October, but the space at our disposal will permit us to mention, quite briefly, only a few of the more recent developments exhibited. Among other new apparatus in the corrosion research laboratory is circulation equipment for studying corrosion and its prevention in flowing water. A test solution is pumped from a lower tank into a header tank and runs back into the lower tank through test specimens which are in the form of mild-steel tubes. Non-corrodible stoneware pumps and glass tanks and pipes are employed and the only metal in the circuit is the material under test.

An investigation carried out on behalf of the British Shipbuilding Research Association on the corrosion of mild-steel tubes in Scotch marine boilers is being actively continued. For this work four model boilers are used: each has six electrically-heated tubes giving a heat-transfer rate of 7,000 B.Th.U. per sq. ft. of tube surface per hour. The question under investigation consists of the influence of the treatment given to the water and the surface treatment of the tubes on the corrosion of mild steels in sea water at a pressure of 190 lb. per sq. in.

In the organic-chemistry section of the Laboratory the technique of gas-liquid partition chromatography has been successfully applied to the analysis of a number of standard samples of organic products prepared in the Laboratory. Another technique recently developed by the organic group for the preparation of organic compounds of high purity is that of zone melting. This method was originally employed for the purification of such metals as germanium but it is now found to be applicable, to an increasing extent, in the sphere of organic chemistry.

WIND LOADING ON ROOFS

With Special Reference to High Suctions

By J. D. Haddon, M.B.E., B.SC., F.R.AE.S.

The use of heavy stones on roofs in Alpine districts demonstrates how practical experience has shown the importance of the suction effect of the wind. It was only comparatively recently, however, that any suction effect was allowed for in roof design. It was first recorded by Irminger* about 60 years ago. Maximum positive pressure is limited to the stagnation pressure, $\frac{1}{2}\rho V^2$, but maximum negative pressure will exceed this figure wherever the local speed of airflow is more than double that of the undisturbed stream.

The effect of normal airflow across a simple roof is well known, but axial and diagonal flow appears to have been neglected. Bailey† did some work on full-scale and model sheds with the wind in various directions. Unfortunately his pressure points were only on the centre-line of a long shed, so did not show the large suctions which would have occurred towards the windward gable or on a short shed.

The investigation reported here was carried out at the Royal Military College of Science, chiefly with the object of determining the maximum upward pressure a roof should be designed to withstand; this knowledge having become more necessary with the use of lightweight roofing materials and lower factors of safety.

* "Experiments in Wind Pressure." Irminger, *Proc. I.C.E.*, Vol. 118, page 468 (1893-94).

† "Wind Pressure on Buildings." Bailey, *I.C.E.*, Selected Eng. Papers, No. 139 (1933).

The wind-tunnel used was of the enclosed type with a 2 ft. square working section. It was run throughout at a velocity of approximately 100ft. per sec. The models were mounted on the floor of the tunnel where the variation of windspeed was not dissimilar to what would occur under full-scale conditions. The stagnation pressure was obtained from a Pitot-static head situated $2\frac{1}{2}$ in. from the tunnel roof, which corresponds to a position $\frac{1}{2}$ in. above the eaves of all models tested. The models were 4 in. wide with 2 in. high sides. Three had sloping roofs of 15 deg., 30 deg. and 45 deg. and a fourth, representing a shell roof, had a roof radius of 2·83 in. Some of the models are shown in Fig. 1. The top two are master models which fit into a turntable on the tunnel floor. Extensions may be attached at the ends by dowels, and the joints covered with cellotape. The Reynolds Number varied from 210,000 to 550,000 according to the length of the model.

The static pressure at the Pitot head was taken as zero and all dynamic pressures (p) were divided by the stagnation pressure (p_s). This made the work easier, allowed for changing conditions of velocity and air density. It gave results readily applicable to all similar structures by multiplying by $0{\cdot}0026\,V^2$, where V is wind speed in m.p.h. Results could be taken directly from manometer readings, without conversion to dimensional units. Where pressures are quoted as average pressures over a line of

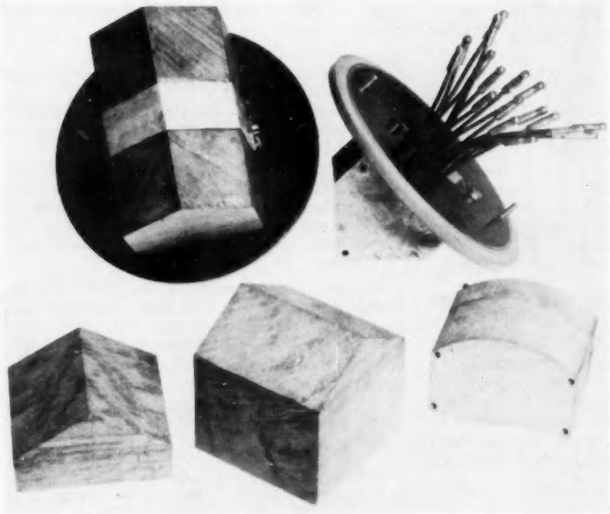


Fig. 1 Some of the models used to determine the maximum uplift a roof should be designed to withstand.

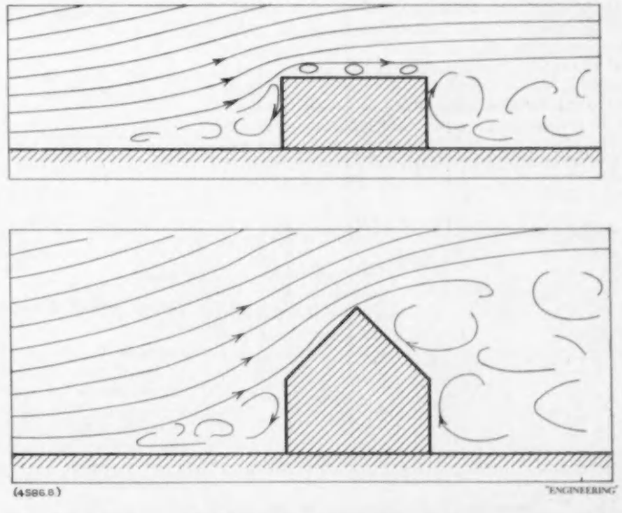


Fig. 2 Flow patterns for flat and angled roofs. Suction occurs over all of flat or small-angled roofs, but there is a positive wind pressure on the windward side of large-angled roofs.

Continuing Research and Development

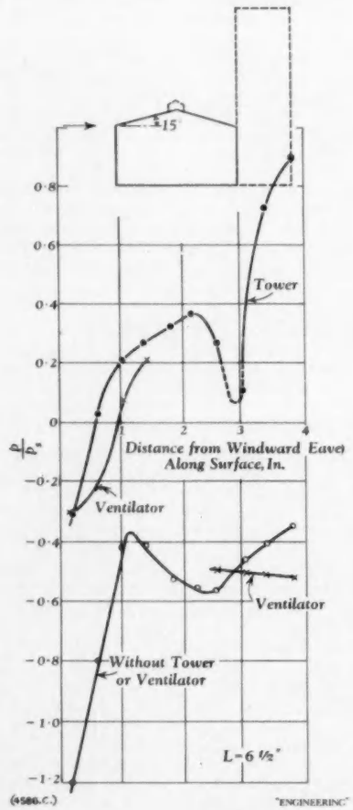
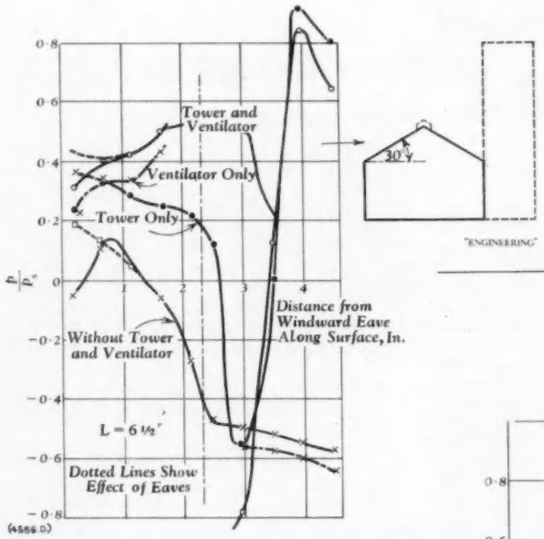


Fig. 3 Effect of a normal wind on a 15 deg. roof.



Figs. 3, 4, 5 and 6 The effects of a normal wind on various obstructions are shown in these four illustrations. In each case the added effects of eaves, a ridge ventilator or an adjacent tower are also shown. The ventilator has an effect out of all proportion to its size.

Fig. 4 Effect of a normal wind on a 30 deg. roof.

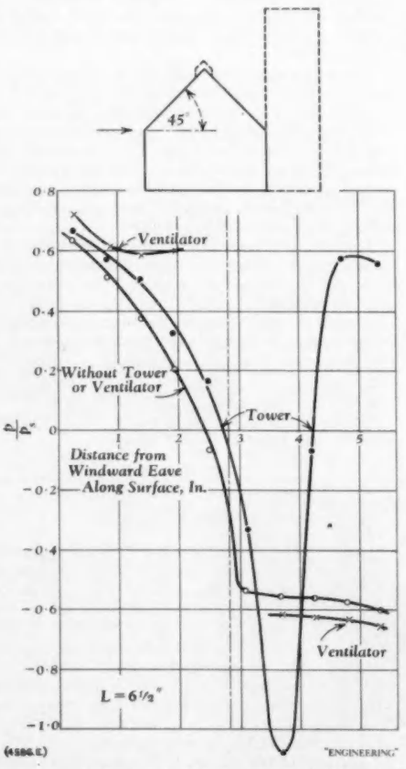


Fig. 5 Effect of a normal wind on a 45 deg. roof.

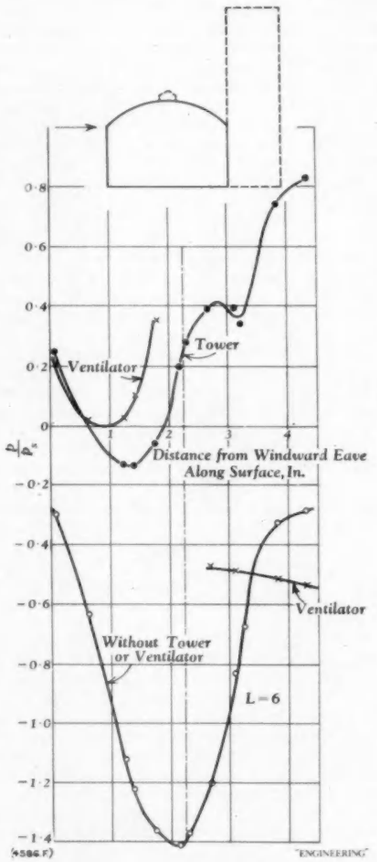


Fig. 6 Effect of a normal wind on a typical shell roof.

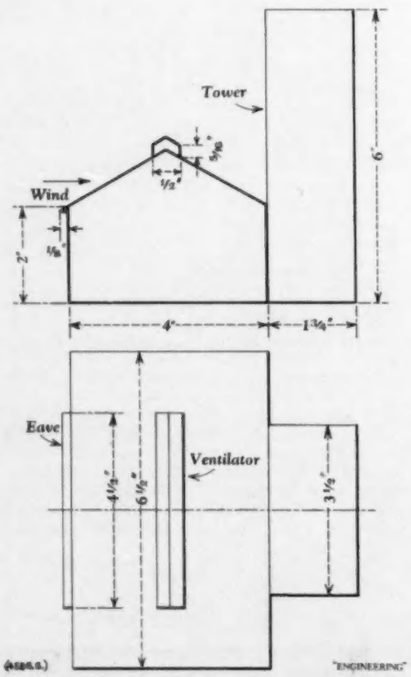


Fig. 7 Dimensions and positions of the eave, ventilator and tower. The effect the presence of these obstructions has on normal wind loading is shown in the other illustrations on this page.

pressure points, use is made of the symbol p_a.

There has, as yet, been no opportunity to check results for scale effect at higher Reynolds Numbers. This effect is expected to be slight with the bluff model shapes, except perhaps in the case of the shell roof, under normal flow, where suctions may increase at higher Reynolds Numbers.

WIND-TUNNEL EXPERIMENTS

Study of flow patterns, two of which are illustrated in Fig. 2, point to the following:—

(i) Flat and small-angled roofs will have suction all over.
(ii) Large-angled roofs will have positive pressure to windward, changing to suction just before the apex.
(iii) A prismatic roof, with axial flow, similar to the flat roof, will have a large suction forward reducing to a small one farther aft.
(iv) Small obstacles, which change the flow pattern, will have a comparatively large effect.

Normal Flow.—Results of tests with the airstream normal to the roof have been published by Stanton* and by Bailey and Vincent.† However it is inevitable that there will be small variations in the results of each experimenter, principally due to:—

(i) Aspect ratio and relative height of model.
(ii) Relative size of model and tunnel.
(iii) Velocity gradient in tunnel.

* "Wind Pressure on Buildings, including Effect of Adjacent Buildings." Bailey and Vincent, *Jour. I.C.E.*, Vol. 20, page 243 (1942-43).

† "Stanton on the Resistance of Plane Surfaces to a Uniform Current of Air." *Proc. I.C.E.*, Vol. 154, page 78 (1903-4).

(iv) Position to which velocity of undisturbed stream refers.
(v) Position and number of pressure points.
(vi) Change of Reynolds Number.

Curves marked "Without Tower and Ventilators" in Figs. 3, 4, 5 and 6, show the pressure distribution along the centre-line for normal flow across the models. It will be noted that a small-angled roof is subjected wholly to suction, which on the windward slope changes to a positive pressure as the angle is increased, while on the leeward slope there is a slight increase of suction. The shell roof is subjected to a large suction, especially near the centre. At 75 m.p.h. this suction would equal

$$1{\cdot}4\,p_s = 1{\cdot}4 \times 0{\cdot}0026 \times 75^2 = 20 \text{ lb. per sq. ft.}$$

Experiments showed that pressure varied with aspect ratio $A\left(\frac{\text{length}}{\text{breadth}}\right)$, and distance from gable ends, but this variation was not large.

It was decided to test the effect of an eave, a closed ventilator structure on the apex and a tower to leeward. The size and position of these is shown in Fig. 7. Figs. 3, 4, 5 and 6, show the results of these tests, they are self-explanatory. It will be seen that the ventilator has an effect out of all proportion to its size. The tower, as a result of deflecting the airflow concave upwards, produces a positive pressure on the leeward slopes, which is higher on the flatter roofs.

Axial Flow.—Tests with axial flow showed that suction was almost constant over any transverse section, but varied considerably along the length of the model. That the suction at a given distance from the windward gable is almost independent of the model length is shown in Fig. 8. Fig. 9 shows the results for the four roofs tested. The differences appear to be chiefly due to variation in projected area.

Angular Flow.—It was found that with a single 30 deg. roof the greatest average suction on the leeward slope occurred when the windstream was at 50 deg. to the axis. On the windward slope it was greatest with axial flow. The graph Fig. 10 gives the variation of suction with distance from the windward end for a 50 deg. airstream. Further experiments showed that the maximum suction, on the leeward slope, increased with aspect ratio.

Internal Pressure.—Critical conditions will depend upon the difference between internal and external pressures. It was found that internal pressures varied from $0{\cdot}75\,p_s$ with axial flow and windward door open, to $-0{\cdot}85\,p_s$, with axial flow and side door open near the windward end. Fig. 11 shows the variation of internal suction with side door position, full line, and with length, dotted curve.

CONCLUSIONS

It is clear that Codes of Practice do not take sufficient account of the suction under axial flow. The worst case of lift, on a single isolated building, occurs on a prismatic shed roof with axial windstream and windward doors only open. This gives a net upward pressure towards the windward end of 22½ lb. per sq. ft. at 75 m.p.h. Although a long roof with axial flow will everywhere be subjected to suction, there would be a net downward pressure of $0{\cdot}7\,p_s$, towards the rear, if doors and windows are open only at the sides near the windward end. The effect of small obstructions may considerably change the wind loading. Further investigation is required into the effect of interference.

Acknowledgment.—The author desires to acknowledge the help received from the members of the laboratory staff of the Department of Mechanical Engineering, Royal Military College of Science and to thank them for their assistance and interest in the work. It may also be mentioned that a full report of this investigation has been deposited in the library of the Institution of Civil Engineers, London, S.W.1.

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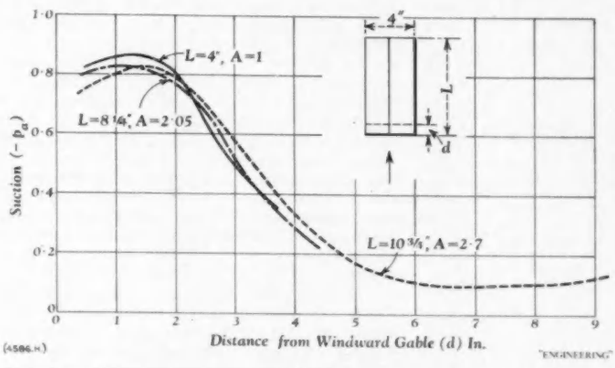

Fig. 8 (left) Suction on a 30 deg. roof when the wind blows axially along the length of the building.

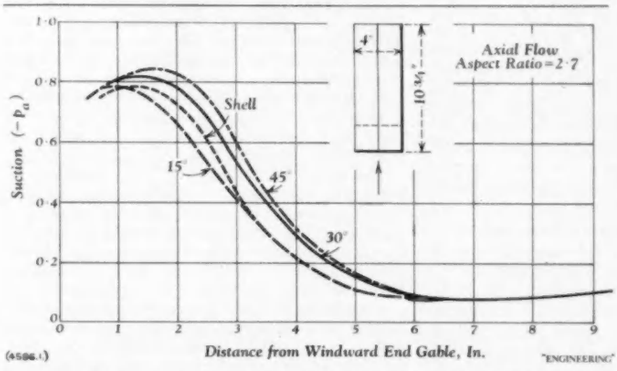

Fig. 9 (left) Suction at different distances from windward end gable with axial flow.

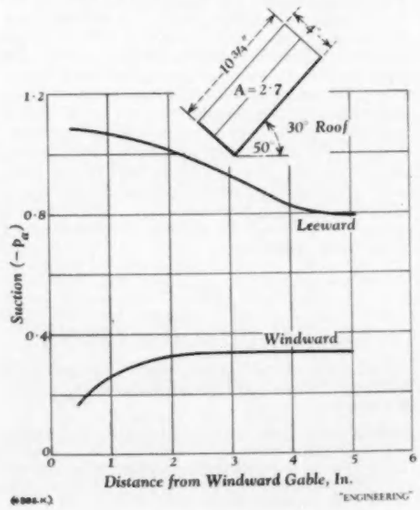

Fig. 10 (left) Suction due to flow at 50 deg. to axis.

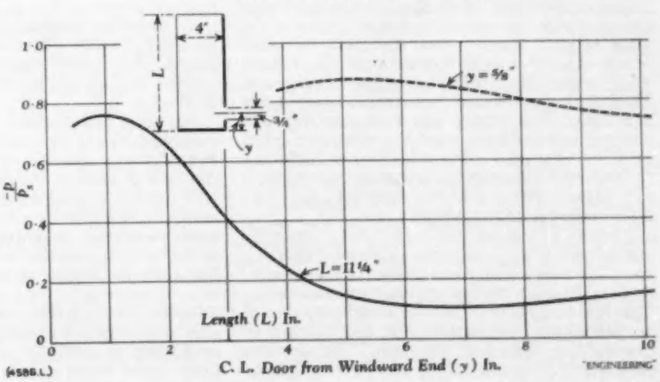

Fig. 11 (right) Internal suction with a side door open.

CHECKING TELEVISION TRANSMITTERS

An instrument for analysing the radio frequency output of a television transmitter has recently been put on the market. It displays the overall response of Band I or Band III transmitters using 405, 525 or 625 line systems. The instrument provides a sweep signal for modulating the transmitter and scans the resultant radio frequency output in such a way as to display the upper or lower sideband response.

The test signal is a composite signal: normal television wave forms are combined with the video test signal and the transmitter operates on test at any level in the grey scale, under the same conditions as in normal service. This allows quicker checking of transmitter performance. Also, the effect of any adjustment to the transmitter is made immediately visible.

The instrument, the television transmitter sideband analyser type OA1241, was designed by Marconi's Wireless Telegraph Company Limited, and is now being produced and marketed by Marconi Instruments Limited, St. Albans, Hertfordshire. It comprises a sweeper unit, blanking unit, and receiver unit assembled in one case, and a power unit in a separate case. A converter can be added for operation with Band IV and V transmitters.

Book Reviews

HELPING OPERATORS TO WORK BETTER

Outline of Work Study. Part III: Work Measurement. Production Management, Series 2c. *British Institute of Management, Management House, 80 Fetter-lane, London, E.C.4.* (12*s.* 6*d.*)

Since the second World War the great need to increase industrial production in Great Britain has focused attention on what is now known as work study. *Outline of Work Study* is a modern presentation of the practices of the pre-war Bedaux and other management consultants who followed Gilbreth, Taylor and Gantt. Stripped of its jargon, work study is seen to be a rational examination and re-ordering of work in which time study is applied finally as a basis for production planning and for wage incentive schemes. Work study technicians have been responsible for increasing production by amounts up to 200 per cent. over pre-study values, though such marked increases necessarily indicate initial bad management. Such results do, however, show the effectiveness of methods which, applied to the organisation of work, generally cost little though they may save considerable capital outlay in manpower, equipment and premises. It can be effective where the job depends largely on movement and on combination of operators; it cannot offer any solutions to technical engineering problems such as those which occur in process production, or to top management questions now being attacked by operational research techniques.

In this series of books, an examination of work study is framed largely around publications and lectures sponsored by Imperial Chemical Industries Limited, and that firm has been most helpful to others in this sphere. Work study has been divided by I.C.I. technicians into two sections which, though convenient for discussion, are sometimes difficult to separate in practice: method study and work measurement. The volume under review covers the latter. It has the limited objective of an "outline," giving both an appreciation of the scope and limitations of the techniques outlined, and the authors have succeeded in writing a useful book of its type which should be widely read.

The practice of work measurement is outlined in a clear manner in conformity with what is accepted on economic grounds. The techniques of direct time study using a stopwatch and rating, synthetic times using standardised data, analytical estimating and Tippett's "snap reading" method—referred to in the second review on this page—are outlined with worked examples so that a non-specialist manager can understand what is done. The anonymous authors must be congratulated on this. It is unfortunate, however, that the fundamental question of why each step is carried out is not fully explored in a book which should be objective in emphasising both the weakness and strength of practices. Some attempt has been made to overcome criticisms which can be made on scientific grounds by saying that these have "no real significance in practice"; on the other hand, a critical reader can detect places where the wording allows the work study "officer" (does this imply he is not a technician?) to face two ways at once behind this excuse. It is well known that a rating can be consistent to within 5 per cent. at the 5 per cent. probability level and this may be considered reasonable for a given job, but the given table of relaxation allowances makes futile any attempt to make ratings consistent by quoting rest figures which are not even rationally, let alone scientifically, described.

Critical comments on time study practices which have been made in the past by experienced men, who are also distinguished academically, are not brought to the attention of the reader. This is to be regretted because work study should be encouraged, though not at the expense of disregarding informed criticism. To disclaim responsibility for the use of the table of relaxation allowances by writing (as on page 37) "indiscriminate use of tables such as that given is something which management should actively discourage" is to employ double talk. The contradictions apparent may well be caused by work measurement being used as a basis for wage-incentive schemes in a manner illustrated in an appendix. In the body of the book the words (page 7) "tables and negotiations can be resorted to, to help assessments" betray the undue influence of wage schemes which may well justify scientists' criticisms of the objectivity of some of the techniques. There is, however, a welcome advance over past teaching in the dropping of the concept of "normalising" to a 60 (performance on Bedaux scale) which was associated with wage incentive schemes; similar courage may be needed for other modifications.

ANALYSIS BY SNAP READING

Work Sampling. By ROBERT E. HEILAND and WALLACE J. RICHARDSON. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York, 36, N.Y.* (6 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (45*s.*)

The practice of industrial engineering is not so generally advanced in Great Britain as it is in the United States of America although our foremost practitioners are recognised as rivalling in quality those in America. Indeed, one of the fundamental advances in technique in this field originated with Mr. L. H. C. Tippett at the Shirley Institute in 1927, when he developed the work-study technique which he called "snap reading," but by others known as "ratio delay," "activity sampling" and now the wholly inappropriate "work sampling." It is founded on the simple concept that a period of time consists of separate instants of time, during each of which work can be observed and classified into a number of categories conveniently defined after consideration of the purpose of study. Momentary observations (similar to that of a camera shutter—hence Tippett's term snap reading) are made of the work at instants of time which are randomly spaced one from the other, and a record is made of the category at each observation. If the work observed is statistically stable in character an estimate of the probability of a certain category of work occurring is given by

$$p = \frac{\text{number of momentary observations of the category}}{\text{total number of observations made}}$$

and the standard error of this estimate is that of a binomial distribution. This estimate is dependent upon certain assumptions about the basis of the method being correct but is applicable to a variety of industrial processes. The method appears deceptively simple to apply so that necessary precautions, including that of preparatory statistical analysis, are often neglected. The method was not applied in this country, except by Tippett himself, until quite recently, when it was reintroduced from the United States where Mr. R. L. Morrow and others had introduced it as "ratio delay." It is extremely useful for studying the activities of workers and machines spread over a large area and a long time, and ideal conditions for its use are found in textile mills. The applications profitably extend over a wide range, including manpower surveys and studies of machine tool and crane utilisation.

The book under review is the first known to be published on the technique and is intended as a elementary instruction manual covering basic theory and practice to those using the technique. It is to be welcomed as the explanations given are clear, in logical order, and would be suitable for most work-study engineers who are not necessarily well versed in statistical method. No less than 84 pages are devoted to setting out and commenting on the application of the process to eight case studies, each very different in character. This is useful as most people do not appreciate the potential value of the technique in many cases where information is either not yet collected or where reliance is placed on stopwatch measurement.

Attention has been paid by the authors to the general precautions to be observed, but unfortunately no comment has been made either on basic assumptions which seem to be true, although no validation of them has been quoted by the authors, or on some arguments which are open to dispute concerning the technique. These criticisms include whether observer effect is really negligible and how time estimates using the technique compare with estimates using the conventional stopwatch method. Though in 1954 Kinniburgh and McTaggart published in *The Manager* a useful article covering the latter point, except for a reference to Tippett's original paper, no British papers are quoted and this is a drawback for British readers, as the American papers, good as they are (particularly by Davidson, Nelson and Malcolm), are difficult to obtain. A natural question for people now using stopwatch timing techniques to ask would be for a comparison between the two methods of the time values obtained, but such a comparison is not given in *Work Sampling* except indirectly in one of the case studies. The possibilities of using memomotion (time lapse) photography in a similar manner to that of snap reading is not discussed by the authors, despite their quoting memomotion in one of their case studies as a method by which the study was "validated."

The term "work sampling," as applied to the particular technique, is unfortunate, because even a conventional stopwatch time study is a work-sampling technique. It would be better to use the older term rather than introduce such a generic term as work sampling to cover a restricted technique like snap reading. There is a tendency in industrial engineering to see the subject as a loosely strung fabric of techniques rather than a practical philosophy in which scientific techniques of many types are applied. This book follows this tendency and discussion of fundamental issues, such as linkage with memomotion and with stopwatch time study, is avoided. This makes it very useful for those who want only to be told how to apply a technique; it is a disadvantage for those who wish to study the wider aspects, though such people would probably go to the source papers anyhow. Although no new material appears in the book, except for the case histories which are very useful, the authors have nevertheless written a readable book presented in a well-ordered manner, which will be suitable for the average work-study technician.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Anti-Vibration Pads. VULCASCOT (GREAT BRITAIN) LTD., 87-89 Abbey-road, London, N.W.8. Anti-vibration pads for machine mounting which do not require fixing bolts or adhesives, are described. The pads are made in two sizes, 18 in. by 18 in., or

36 in. by 18 in., both $\frac{1}{16}$ in. thick. Manufactured from oil-resistant rubber with grooves running in opposite directions on each side, they will support loads up to four tons per sq. ft. Leaflet.

Cylinder Pressure Check. DUNEDIN ENGINEERING CO., LTD., 51 Beauchamp-place, London, S.W.3. The Diestester attachment, for checking the compression pressures of medium- and high-speed Diesel engines at normal running speed. The probe is bolted in place of the injector in one cylinder and the engine run. Compression pressure is then indicated on the gauge. Illustrated leaflet.

Screens. W. J. JENKINS & CO., LTD., P.O. Box No. 3, Retford, Nottinghamshire. SKB (Schüchtermann & Kremer-Baum, Dortmund) resonance screens are now manufactured under licence by this company. The screens are employed for raw coal, coke and all types of materials from lumps to fines and for dry or wet screening. Plants having throughputs of up to 400 tons an hour are available. Illustrated folder.

Metal in Paste Form. STEDALL & CO., LTD., Broadstreet House, 164 High Holborn, London, W.C.1. Industrial metallic mouldable paste, known as Metolux, developed by M.G. PLASTICS LTD., of 19 Mincing-lane, Blackburn, Lancashire. Recommended as a filler for jigs, domestic equipment and blow-holes in castings and for building-up defects in all metallic parts. The material sets in 30 minutes at room temperature. Leaflets.

Marine Diesel Engines. GÖTAVERKEN, Gothenburg, Sweden. (BOLINDERS CO., LTD., 4 Lloyds-avenue, London, E.C.3). Marine Diesel engines with power ratings from 375 to 1,250 b.h.p. per cylinder, mean indicated pressures of 96 and 125 lb. per sq. in., and operating speeds from 60 to 112 r.p.m. are described in detail, with sectional drawings, in a new catalogue. Brochure number 415.

Fork Truck Attachments. R. H. CORBETT & CO., LTD., Hydrum Works, Burgess-Hill, Sussex. An attachments handbook for fork truck users, covering such items as load clamps, paper roll clamps, brick and block forks, dumpers and scoops, load stabilisers and rotating heads, as well as the extra controls needed for them.

Electric Chain Hoist. TAYLOR-STOKER CO., LTD., 189-191 Drummond-street, London, N.W.1. Munck portable electric chain hoists, lifting capacity 660 to 1,320 lb., lift height 10 ft., for trolley or hook suspension, also heavier models with capacities of up to 10 tons, with one or two hook fittings. Illustrated leaflet.

Mould Release Agents. IMPERIAL CHEMICAL INDUSTRIES LTD., Imperial Chemical House, Millbank, London, S.W.1. The rôle of silicones as mould-release agents in metal casting and in the plastics, rubber and glass industries. Illustrated descriptive pamphlet.

Castings for Water Turbines. GEORG FISCHER A.G., Schaffhausen, Switzerland. Some typical examples of large castings of electric arc-furnace steel for hydro-electric work; their production, composition, machining and testing. Illustrated publication.

On the Shelf

By Frank H. Smith

What a contradictory language ours is. Ordinarily "to experience a reversal" is not anything advantageous and yet Rolls-Royce Limited recently announced with pride that they had completed 2,000 reversals. The point is, of course, that theirs were accomplished with a jet thrust reversal unit. All the same, a foreigner could have some difficulty in working it out. Rolls-Royce assure us that the unit's design is such that it will not come into operation inadvertently during flight thus the reminding one of bomb-aimer during the war who was saying "Left left, right right, back back."

The Sheffield City Libraries evidently serve their industrial community well. I have received a copy of their Bibliography No. 40 on "Cold Heading of Steel" and it is significant that this is the third edition (containing 38 references) of this particular subject-list. Bibliographies so often are left to moulder, once they have been done, and yet a running card-index enables them to be revised quite easily. Copies of this one are free from the City Librarian, Central Library, Surrey Street, Sheffield, 1.

An interesting article appears in *Research* for October, published by Butterworth at 5*s.* 6*d.*, entitled "Machine Translation of Languages." It is by I. K. Belskaja of the U.S.S.R. Academy of Sciences and outlines some of the achievements of the machine-translation research group of the Academy. Apart from the interest of the article it is a good example of type variety with Russian, Chinese and Japanese symbols.

While we are on this subject of mechanical translation, the Library Association has produced a Special Subject List (No. 21) on *The Mechanical Translation of Languages*. It is obtainable, price 2*s.* 6*d.*, from Chaucer House, Malet-place, London, W.C.1.

The list comprises an introduction which gives a historical review and follows this with 129 references to books, periodicals and reports. According to the introduction, the first reference to the possibility of adapting electronic computers to translation work was a report by Dr. A. D. Booth of Birkbeck College, London, and, as a result, facilities were afforded him for further research at the Princeton Institute of Advanced Technology. Dr. Booth's latest contribution was a paper to the British Association meeting at Dublin (see ENGINEERING, September 13, page 339). Interested readers may like to be reminded of a detailed book review on this subject, which appeared on page 136 of our issue of February 10, 1956. The Library Association list has been compiled by F. R. Taylor of the Technical Library, Manchester Public Libraries.

Still on the subject of foreign languages, among the services provided by the Department of Scientific and Industrial Research is one of translation from the Russian. For the most part, the translations are fairly understandable but for the life of me I cannot think why anybody should be interested in this item from the August list: "A method of determining the age of red-haired field voles (*Clethrionomy app.*) and experiments on its use." And as the cost of the translation is £3 12*s.* a copy, I think I can do without this knowledge.

The Electrical Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey, are now making available to the public their *Weekly Abstracts Lists*. These lists average 30 abstracts extracted from the material of some 400 British and foreign journals and they are arranged in order of the Universal Decimal Classification. At £5 5*s.* per annum they may be had typed, either on both sides or on one side of the paper only.

A further contribution to the serial on the writing of report material is contained in the General Motors *Engineering Journal* for the third quarter of the year. It is called "Preparation and Evaluation of an Industrial Report" and summarises the company's experience in the preparation of 2,000 reports over a dozen years. This is followed by an article, called "Why can't the English . . ." which questions the legal phraseology deemed necessary in patent claims. Other interesting articles in this well-produced journal deal with the integral-seal ball bearing and with the development of the air spring. Of more immediate interest to motor-car owners is an item on General Motors investigation into fuel-injection systems.

The September number of the *Transactions of the Institute of Marine Engineers*, Memorial Building, 76, Mark-lane, London, E.C.3, is devoted to the five papers, read on February 6, on "The Education and Training of Naval Architects and Marine Engineers." Probably no branch of engineering produces such remarkable results with so little song and dance, and the training that is an introduction to marine engineering should provide some interesting reading.

NEW BOOKS

Air Pollution in the Iron and Steel Industry. Conference Preprints. Iron and Steel Engineers' Group of the Iron and Steel Institute. *Offices of the Institute, 4 Grosvenor-gardens, London, S.W.1.* (Free to those ordering bound volume of Conference Proceedings.)

The 15 papers presented at a two-day meeting on "Air Pollution in the Iron and Steel Industry," held in London by the Iron and Steel Engineers' Group of the Iron and Steel Institute, on September 25 and 26, are bound up in a stiff-paper covered brochure of 114 pages. Most aspects of the subject are covered and the suppression or the mitigation of the emission of dust, smoke and fumes from sinter plants, coke-oven plants, open-hearth furnaces, oxygen pre-refining processes, arc furnaces, and other installations are considered in detail. Some of the papers deal with conditions in the United States, France, Austria and Germany. The authors of the other papers are engaged in British steelworks or research organisations.

Directory of Railway Officials and Year Book 1957-1958. *Tothill Press Limited, 33 Tothill-street, Westminster, London, S.W.1.* (40*s.*)

Alterations made in last year's edition of this well-known work of reference, whereby all the countries in the world, other than Great Britain and Ireland, were placed in alphabetical order, have received general approval. The changes have accordingly been continued in the present issue and will be retained in future editions. In the current issue, the publishers state that, as a few countries still decline to co-operate, no official details are available for China, Poland and Roumania. Nevertheless, much additional information has been included, without, however, diminishing the book's compactness, which is one of its most noteworthy features.

Technical Reports of the Electrical Research Association, *Thorncroft Manor, Dorking-road, Leatherhead, Surrey.*

"Short-Time Electrical Breakdown of Solids by External Discharges," by K. W. Ogilvie, L/T352 (12*s.* 6*d.*); "The Effects of Cylindrical End Rings on the Distribution of Surge Voltages in Transformer Windings," by E. L. White, S/T69 (12*s.* 0*d.*); "The Direct Lightning Stroke to a Buried Cable," by B. L. Coleman, S/T71 (9*s.* 0*d.*); "The Relation between Dispersion and Moisture Content in Paper Insulation," by D. C. G. Smith, V/T128 (10*s.* 6*d.*); "Testing of H.T. Stabilizers," by S. J. Zgorski, V/T129 (15*s.* 0*d.*); "The Influence of Ultrasonic Waves on Biological Materials," by M. J. Thornley, W/T32 (21*s.* 0*d.*).

L'Énergie Nucléaire dans le Monde. By T. REIS. *Dunod, 92 Rue Bonaparte (6e), Paris, France.* (2,900 *F. Frs.*)

The sub-title given to this 300-page volume on "World Nuclear Energy" is "Programmes et Développements Prévus." After data on terminology and conversion factors, the author deals with the world production of energy since 1952 and estimates the needs of the next 50 years. He then reviews world energy resources taking into account deposits of uranium and thorium, and goes on to consider the power and possible nuclear-energy resources of the 17 European countries of O.E.E.C., and, in greater detail, those of France and the French territories in Africa. The second, and longest, portion of the volume contains a detailed description of the nuclear energy plants, built, under construction, or projected, in some 40 countries throughout the world. The sections devoted to Great Britain, the United States, Russia, Canada, Germany and France are lengthier than those given to other countries. The book closes with a bibliography.

Gas Turbine Materials. A Survey of High-temperature Materials and Their Application to the Gas Turbine. By G. LUCAS and J. F. POLLOCK. *The Temple Press Limited, Bowling Green-lane, London, E.C.1.* (25*s.*)

The practical realisation of the gas-turbine depends as much on developments in the metallurgical field as on aerodynamic advances, and the authors indicate how material requirements arising from operating conditions in the gas turbine are being met by special high-temperature materials. In their preface the authors state that their book is intended to be a survey and not a detailed treatment of the field of gas-turbine materials. The purpose of the work is to bridge the gap between metallurgical text-books and works concerned with the technology of the design and performance of gas-turbines.

Design

MORE STEEL OR BETTER CONCRETE FOR CHEAPER DESIGNS

AN ECONOMIC APPROACH TO REINFORCED CONCRETE

By J. R. Lawrence, B.SC.(ENG.), PH.D.

It is very easy to see that in designing a structural member to be made of a single homogeneous material, such as steel, the quantity of material required is least if the maximum calculated stress is made equal to the maximum permissible stress for that material. Reinforced concrete is a composite material whose components, concrete and steel, differ enormously both in properties and in price; it appears to be generally accepted that it is always best to assume, in the design office, that the maximum calculated stress in each material should be equal to its maximum permissible stress. It is the purpose of this article to discuss the validity of that assumption.

THEORY

Use will be made of the following symbols:

- M Bending moment.
- F Maximum stress in steel.
- f Maximum stress in concrete.
- b Breadth.
- d Depth.
- nd Neutral axis depth.
- A_s Cross-sectional area of steel.
- m Modular ratio.

The classical theory for the design of a rectangular-section reinforced-concrete beam gives the following well-known relationships:

$$M = \tfrac{1}{2} b n d^2 f \left(1 - \frac{n}{3}\right). \quad . \quad (1)$$

$$\frac{F}{mf} = \frac{1-n}{n}. \quad . \quad . \quad . \quad (2)$$

rearranged, equation (2) gives:

$$n = \frac{mf}{F + mf}. \quad . \quad . \quad . \quad (3)$$

Thus:

$$1 - \frac{n}{3} = \frac{3F + 2mf}{3(F + mf)}. \quad . \quad (4)$$

Substituting equations (3) and (4) in equation (1):

$$M = \frac{1}{6} b d^2 f^2 m \frac{(3F + 2mf)}{(F + mf)^2}. \quad (5)$$

The cross-sectional area of the concrete (ignoring cover) is:

$$bd = \frac{6M(F + mf)^2}{dmf^2(3F + 2mf)}. \quad . \quad (6)$$

It may be shown that the cross-sectional area of the steel is:

$$A_s = \frac{M}{dF\left(1 - \frac{n}{3}\right)}. \quad . \quad . \quad (7)$$

Substituting from equation (4):

$$A_s = \frac{3M(F + mf)}{dF(3F + 2mf)}. \quad . \quad (8)$$

If the total cost per unit volume of concrete is C, and the cost per unit volume of steel is rC, then the total cost per unit length of a beam is:

$$L = \frac{6MC(F + mf)^2}{dmf^2(3F + 2mf)} + \frac{3MCr(F + mf)}{dF(3F + 2mf)}$$

$$= \frac{3MC}{d}\left\{\frac{2(F + mf)^2}{mf^2(3F + 2mf)} + \frac{r(F + mf)}{F(3F + 2mf)}\right\}. \quad . \quad . \quad . \quad . \quad . \quad (9)$$

In any particular case M and C are constant. Since each component of the total cost is inversely proportional to the depth of the beam, then the quantities of both steel and concrete will be minimised by taking the maximum possible depth of beam. This will normally be fixed by architectural considerations, and can therefore be taken as constant. Denoting the term $\frac{3MC}{d}$ by K, to determine the minimum cost it is necessary to minimise the function:

$$\frac{L}{K} = \frac{2(F + mf)^2}{mf^2(3F + 2mf)} + \frac{r(F + mf)}{F(3F + 2mf)}. \quad . \quad . \quad . \quad (10)$$

A typical value for $\frac{L}{K}$ is 0·002 sq. in. per lb.

DISCUSSION OF VARIABLES

Of the four variables (F, f, m and r) in the function in equation (10) F and f may have any value up to the maximum permissible stresses for the particular types of steel and concrete being used; m is usually taken as 15 but a lower value would bear more relation to the actual properties of the concrete; and r is a term whose value is open to discussion. The actual cost of the materials is easily obtained but a variation in the quantity of steel in a structure also involves more bending and more erection labour. Similarly, more concrete involves more mixing and more shuttering. Considering only materials, the cost of concrete is about a tenth of that of steel, weight for weight, which puts the value of r (the ratio of cost by volume) at about 30. It is thought that the indirect costs of concreting are greater than those of steelwork, since it involves far more equipment and labour and such services as quality control, in addition to those already mentioned.

There is not enough information available to enable the value of r to be determined exactly, and furthermore it will vary with prices and wages. Therefore a range of from 10 to 30 has been taken.

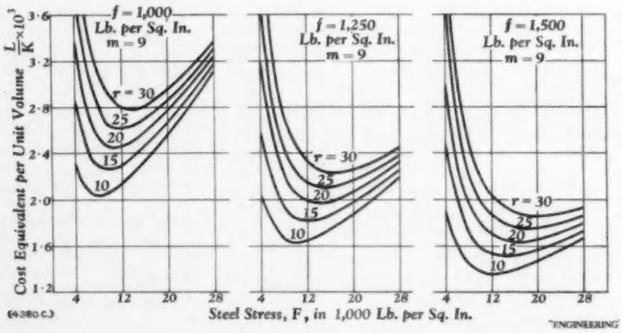
The calculations have been performed for m = 15, and also for m = 12 and 9. At this stage, values of F and f, the maximum stresses in steel and concrete, were considered up to 27,000 lb. per sq. in. and 1,500 lb. per sq. in., respectively, the maxima allowed for any steel and concrete by the Code of Practice.[1]

METHOD

It was required to find which values of f and F gave minimum values of the function $\frac{L}{K}$ in equation (10), for various values of m and r. As a first step the function was differentiated partially with respect to f and F. For a minimum with respect to f it was found that the condition for $\frac{\partial\left(\frac{L}{K}\right)}{\partial f}$ to be zero could be put in the form:

$$m^2 f^2 \left(\frac{r}{4} - m\right) = 4m^2 f^2 F + 6mfF^2 + 3F^3.$$

Since the maximum value of r considered is 30 and the minimum value of m is 9 and all the terms have finite positive values, the above relationship can never hold true. Therefore $\frac{\partial\left(\frac{L}{K}\right)}{\partial f}$ is never zero, and is in fact always


f = 1,000 Lb. per Sq. In. m = 9
f = 1,250 Lb. per Sq. In. m = 9
f = 1,500 Lb. per Sq. In. m = 9
r = 30
25
20
15
10
Cost Equivalent per Unit Volume L/K ×10³
Steel Stress, F, in 1,000 Lb. per Sq. In.
(4380.C)
"ENGINEERING"

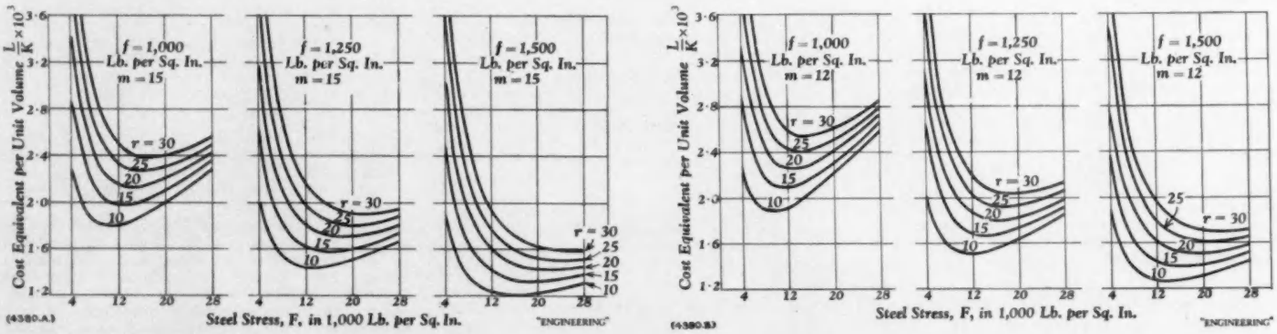

f = 1,000 Lb. per Sq. In. m = 15
f = 1,250 Lb. per Sq. In. m = 15
f = 1,500 Lb. per Sq. In. m = 15
f = 1,000 Lb. per Sq. In. m = 12
f = 1,250 Lb. per Sq. In. m = 12
f = 1,500 Lb. per Sq. In. m = 12
r = 30
25
20
15
10
Cost Equivalent per Unit Volume L/K ×10³
Steel Stress, F, in 1,000 Lb. per Sq. In.
(4380.A)
(4380.B)
"ENGINEERING"

Fig. 1 Cost equivalent per unit length $\frac{L}{K}$, of reinforced concrete beams against the maximum steel stress, giving a minimum total cost for three values of the modular ratio and considering three strengths of concrete for each modulus. It is possible, using the graphs, to calculate how much it is worth spending on making stronger concrete in order to make the final design cost less.

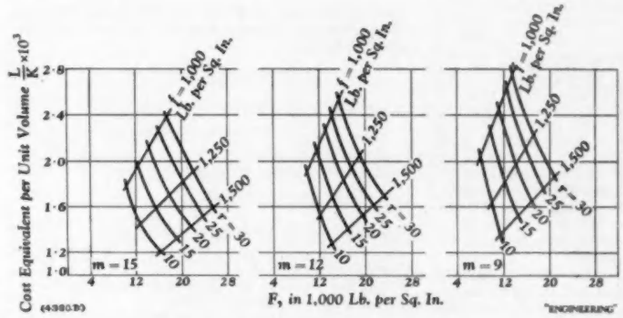


Fig. 2 Minimum beam costs and optimum design steel stresses for different qualities of concrete, in terms of maximum stress, modular ratio and cost ratio with steel.

negative. Thus the lowest cost is given by taking the maximum value of f. Depending on the type of concrete, this may be 1,000, 1,250 or 1,500 lb. per sq. in.

Differentiation of equation (10) with respect to F yielded a quartic equation in F. Since there are 45 combinations of values of m, r and f there were in fact 45 quartics to solve, a process more difficult than the painstaking calculation of the various values of $\frac{L}{K}$ to find the various minimum values for each of the combinations. This latter method was adopted and although laborious the work was reduced considerably by a systematic programme and the use of an appropriate calculating machine.

RESULTS

The graphs in Fig. 1 show the total cost, divided by the constant K, plotted against the maximum stress in the steel of a rectangular reinforced-concrete beam for different values of f and m. Curves are given for values of r of 10, 15, 20, 25 and 30, values of f of 1,000, 1,250 and 1,500 lb. per sq. in., and values of m of 15, 12, and 9. In Fig. 2 the minimum values of $\frac{L}{K}$ from Fig. 1 have been collected together, so that for each combination of values of r, f and m the optimum value of F and the corresponding value of $\frac{L}{K}$ can be read off.

CONCLUSIONS

For all combinations of the variables there is an optimum value of the maximum steel stress, giving a minimum total cost, lying between 8,000 and 25,500 lb. per sq. in. Under many sets of conditions, in the design of rectangular-section beams, a saving in the total cost of a beam will be effected by the assumption, in the design office, of a maximum steel stress lower than that normally allowed by the Code of Practice. The process by which this occurs is that the reduction in the maximum stress in the steel increases the neutral-axis depth (equation 2), making greater use of the compressive properties of the concrete. The length of the lever arm is thereby reduced, and a slightly greater quantity of reinforcement is required. The saving in the quantity of concrete used is greater than the extra cost of reinforcement, and at the optimum point the saving is greatest. In addition, a more slender beam is obtained, which may well be desirable architecturally.

In the most common case, where m is taken as 15 and the maximum compressive stress in the concrete as 1,000 lb. per sq. in., for all values of r up to 30 the optimum steel stress lies below the maximum allowable stress for mild steel, namely 18,000 lb. per sq. in.

To take an example, assume that the value of r is 15; the values of $\frac{L}{K}$ corresponding to maximum steel stresses of 18,000 and 12,500 lb. per sq. in., the maximum allowable and optimum values, are 2·06 and 1·98 respectively. This represents a saving of 4 per cent. in the cost of the beams, for no action other than using a lower maximum steel stress in the design office.

A more interesting result comes from the consideration of the use of high-tensile steel bars in reinforced concrete. High-tensile steel is more expensive than mild steel, and therefore the value of r is greater. Referring to Fig. 1, under no circumstances can the use of a more expensive steel, albeit with a higher maximum permissible stress, give any advantage in the total cost over the use of mild-steel reinforcement with a maximum permissible stress of 18,000 lb. per sq. in.

It is also interesting to consider the economics of the use of high-strength concrete. Is any saving achieved by using more expensive high-strength concrete? If the cost per cubic foot of concrete were not altered the saving would be considerable. But the cost of high strength concrete is higher, and therefore $K\left(=\frac{3mC}{d}\right)$ is higher, and r is lower. To estimate whether the saving, assuming no change in the cost of the concrete, is greater or less than the increase in cost due to that change, it is necessary to know the costs of both types of concrete. By using the graphs for a number of examples it was observed that, in general, the use of a concrete giving a compressive strength of 1,500 lb. per sq. in. is more economical than the use of one giving 1,000 lb. per sq. in. provided that the cost per cubic foot of the former is less than about twice the cost of the latter.

Using the mix proportions required by the Code of Practice to give these maximum permissible stresses, and taking the cost per ton of cement and aggregate as 95*s.* 6*d.* and 12*s.* 9*d.* respectively, the ratio of the costs per unit volume of concrete of 1,500 and 1,000 lb. per sq. in. is 1·3, based on the cost of materials alone. When the indirect costs are included the ratio is reduced. Therefore, it is definitely an economical proposition to spend more making stronger concrete, in order to make a reduction in the cost of the beams when designed to the higher stress.

It may be argued that to save 4 per cent. in the cost of concrete beams, by using extra steel, is unwise because of the shortage of reinforcing steel. However, this is not necessarily a permanent restriction and does not affect the validity of the theory. Also, any shortage of steel to the civil engineering industry has a solution largely lying in the policy of those whose job it is to decide the materials to be used in our major buildings. Baker[2] has said that about 500,000 tons of structural steel are used annually in building frames in Britain. This could be reduced to about 180,000 ton by the substitution of reinforced-concrete designs. According to *B.I.S.F. Monthly Statistical Bulletins* and *Iron and Steel Monthly Statistics*, the consumption of reinforcing steel in Britain in 1955 was 364,000 tons. Thus, on 1955 consumption, 864,000 tons of steel annually is going into building that could be done with 544,000 tons, if all steel-frame designs were replaced by reinforced-concrete designs.

It is emphasised that the results so far obtained apply only to simple rectangular beams, although it is intended to apply similar techniques to more complicated structural members.

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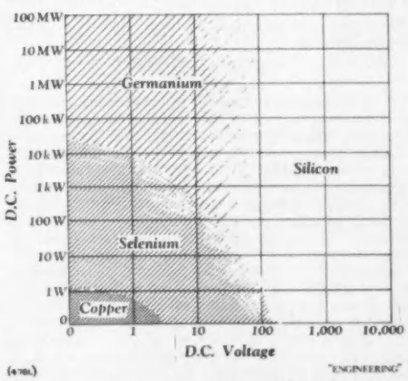
[1] *The Structural Use of Normal Reinforced Concrete in Buildings.* British Standard Code of Practice, C.P.114 (1948).

[2] "Concrete Versus Steel as a Building Frame," by A. L. L. Baker. *The Times*, October 3, 1956.

RECTIFIERS AND SEMI-CONDUCTORS

The "metal" rectifier has gone a long way since the first was built about 1921. The Westinghouse Brake and Signal Company, Limited, 82 York-way, King's Cross, London, N.1, showed this clearly at a recent open day and demonstration held at their Chippenham works. In the exhibition room the history of the rectifier was displayed together with examples of modern equipment.

The first rectifier was made from the copper/copper oxide combination and similar models are still being produced in large quantities. The main limitation is temperature; satisfactory operation is limited to about 50 deg. C. They also require a fairly large surface area. Selenium came next, and again still holds its popularity.



The power range of metal rectifiers has been enormously increased by the introduction of two semi-conductors, germanium and silicon.

A modern development is the use of light alloy instead of steel for backing strips, offering a considerable saving in weight. However, selenium rectifiers suffer from much the same disadvantages as copper—temperature limitation (maximum is about 75 deg. C.) and size.

Although the development of new processes for the manufacture of copper oxide rectifiers, by which the reverse current resistance has been doubled, will undoubtedly re-awaken interest in this form, it is probable that most interest will be centred for some time in the two semi-conductors, germanium and silicon. Both offer a vast reduction in size compared to either copper oxide or selenium, while silicon not only offers the greater reduction, but can be operated at higher temperatures—up to 160 deg. C. with safety. (Germanium has a maximum of about 78 deg. C. —similar to selenium.) However, the reduction in size has brought with it the problem of heat dissipation, and neither form is capable of withstanding the overloads that copper oxide or selenium types will take—almost entirely on that account.

Forced cooling can be used to overcome the heat dissipation of the small-sized rectifier, and so the transformer is now by far the largest and heaviest item in an equipment. Efforts are now therefore being directed to reducing transformer size, and an experimental model rated at 150 kVA was shown, wound on what was normally a 50 kVA frame. Water cooling by flattened tubes running through both the iron and the windings permitted this increase in output.

As regards future work, it has been announced that there will be full interchange of information between the British and American Westinghouse companies in respect of development work on semi-conductors.

Production

CROP CONSERVATION PRACTICE*

By J. R. O'Callaghan, B.E., M.SC.

Many traditional methods of crop conservation have proved inefficient in mechanised farming. Some, such as tripod hay-making, are not suitable for modern machinery; others, such as hay-making on the ground, are wasteful of nutrients. Compound machinery, however, may also omit some useful stages in the old methods; for instance, the grain-drying in the stook possible with a reaper-and-binder has to be omitted when using a combine-harvester.

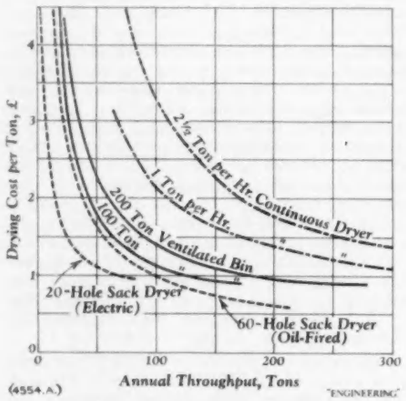


Fig. 1 Cost of grain drying.

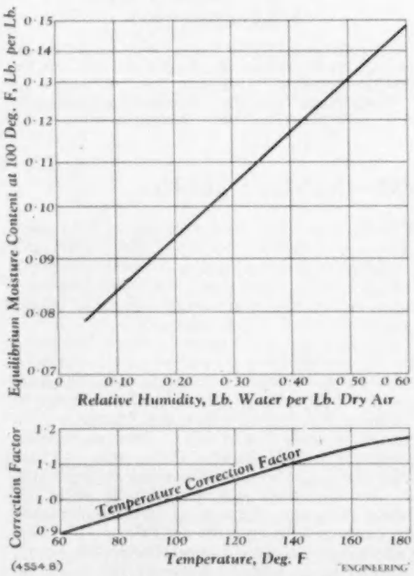

Equilibrium Moisture Content at 100 Deg. F, Lb. per Lb.
Relative Humidity, Lb. Water per Lb. Dry Air
Correction Factor
Temperature Correction Factor
Temperature, Deg. F
(4554.B.)
"ENGINEERING"

Fig. 2 Effect of air humidity on equilibrium moisture content of wheat.

A satisfactory conservation method must provide cheap storage with the minimum loss of nutrients.

GRAIN DRYING

On the arable farm the main conservation problem is the drying of grain at harvest time. The combine-harvester which cuts, threshes and collects the grain, is a cheap and labour-saving method of harvesting, but the climate of north-west Europe requires artificial drying to reduce the moisture content to a safe value for storage. Drying facilities may be provided on the farm itself or by a contractor. A recent survey of drying costs by Nix[1] has shown that the cost of drying grain on the farm compares favourably with contractors' charges even for small annual tonnages, provided a suitable plant is chosen. The results are summarised in Fig. 1.

* Paper read before Section G of the British Association at Dublin, on Monday, September 9, 1957.

The ventilated bin method of drying is satisfactory for drying grain in bulk, with a low moisture content. Except in dry regions auxiliary heating of the air is necessary. With electricity the first cost is low but the charges for heating are appreciable and it is desirable to increase the efficiency.

By air-drying thin layers of wheat, approximately one grain thick, under controlled conditions of temperature and humidity, it has been shown[2] that the rate of drying can be expressed in the form

$$-\frac{\partial W}{\partial \theta} = 2{\cdot}3\, m\,(W - W_e)$$

where W is the moisture content (lb. water per lb. dry matter)

W_e is the dynamic equilibrium moisture content (lb. water per lb. dry matter),

m is a rate constant (hour^{-1}).

The dynamic equilibrium moisture content is the asymptotic value of moisture content which a thin layer of wheat approaches during through-air-drying. Over the range of drying conditions used in practice it can be expressed[3] as a function of relative humidity with a slight temperature correction as shown in Fig. 2.

In a thin layer of wheat, the rate constant m is independent of the velocity and relative humidity of the drying air and depends only on its dry-bulb temperature[2]:—

$$\log_{10} m = \frac{t - 159}{87}$$

A semi-graphical method of calculating the rate of through-air-drying of deep beds of wheat has been developed from the results of the thin layer experiments.[4] It assumed that a deep bed may be regarded as a number of thin layers in series, that the rate of drying in each layer remains constant during a short time interval, and that the total heat of the drying air remains constant in passing through the bed of wheat. The drying curve for a deep fixed bed of wheat is found as follows (see Fig. 3). On a psychrometric chart (*a*) plot the total heat line corresponding to the condition of the drying air entering the bed. At (*b*) plot the rate constant m' (min.$^{-1}$ for convenience) as a function of the dry-bulb temperature. The relative humidity of the air passing through the grain may be read from the psychrometric chart at any dry-bulb temperature; the corresponding value of dynamic equilibrium moisture content is plotted at (*c*). The moisture content of the wheat in the bed is plotted against an equivalent number of thin layers (*d*).

During the interval of time θ_1 minutes in the first layer of wheat at commencement of drying and under inlet air conditions

$$-\frac{\partial W}{\partial \theta} = 2{\cdot}3\, m'_0\,(W_0 - W_{e0})$$

Weight of water liberated per minute is

$$2{\cdot}3\, m'_0\, \beta\,(W_0 - W_{e0})$$

where β = weight of dry stock in a layer.

Increase in absolute humidity of drying air

$$\Delta H = 2{\cdot}3\, m'_0\, \beta\, \frac{W_0 - W_{e0}}{G}$$

where G = rate of air flow (lb. per minute).

Decrease in moisture content of stock in θ_1 min. = $2{\cdot}3\, m'_0\, \theta_1\,(W_0 - W_{e0})$.

From the increase in absolute humidity ΔH of the drying air in passing through the first layer of wheat, conditions at entry to the second layer can be located, 1, Fig. 3 (*a*). The decrease in moisture content in every layer is plotted at (*d*). The curve drawn through these points shows the moisture content in the bed of grain at the end of θ_1 minutes. The amount of drying in the next interval of time is found by using the concentration gradient $(W_{\theta 1} - W_e)$. This method of calculation of drying curves was shown by experiment to be sufficiently reliable for design purposes.[4] It showed that in through-air-drying a fixed bed of wheat, the capacity of a dryer and its efficiency increased as the temperature of the air and the thickness of the bed of wheat were increased. There are limitations to this system of drying: (i) The maximum temperature of the air is that which will not damage the grain: 150 deg. F. for milling wheat and 120 deg. F. for seed grain. (ii) A deep static bed gives a gradient in moisture content

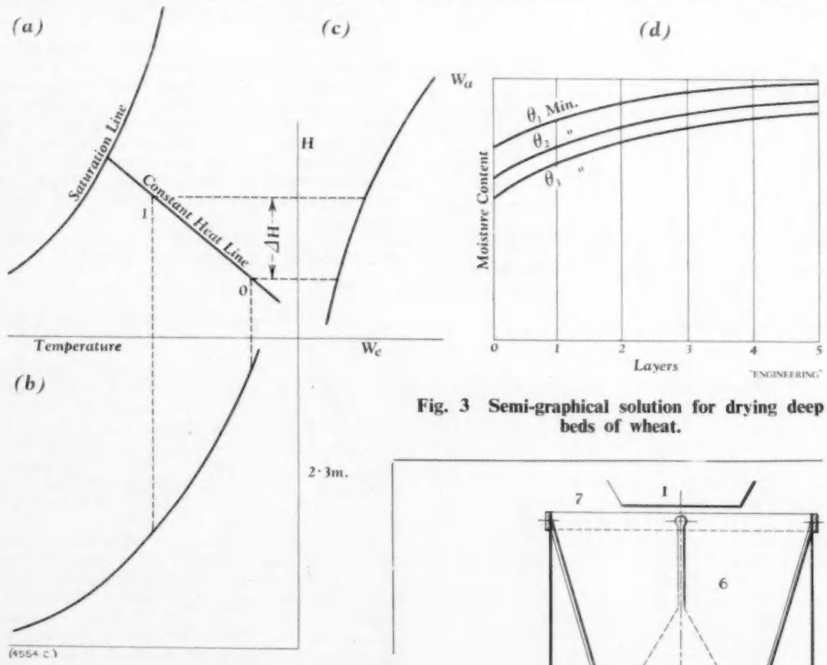


Fig. 3 Semi-graphical solution for drying deep beds of wheat.

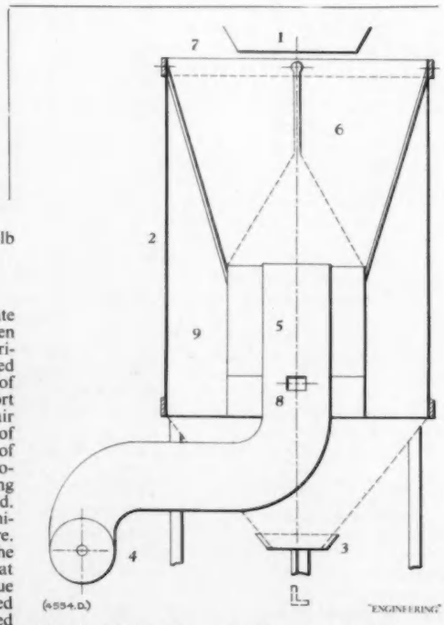


Fig. 4 Design for contra-flow electrically heated grain dryer.

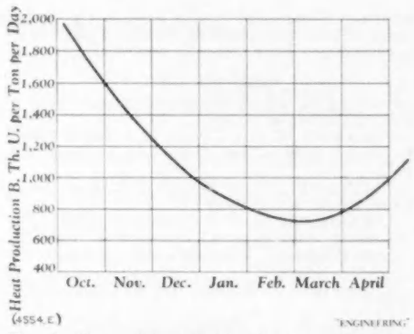


Fig. 5 Rate of heat production by potatoes in storage.

with the result that the bottom layers are over-dried and the top layers are too damp for storage.

It seems then that the principle of contra-flow is ideally suited for drying grain efficiently. If fresh grain is continually fed on to the top of the bed as rapidly as dried grain is removed from the bottom of it, the drying capacity of the air will be used efficiently and the moisture content of the grain leaving the dryer will be uniform.

The semi-graphical method of calculating the drying curve for a deep bed of grain has been modified to find the drying-curve during the transient stage when a contra-flow dryer is started up.[5] In this case the origin of the number of thin layers equivalent to the deep bed (Fig. 3) (*d*) is changed at the end of every time interval by an amount equal to the quantity of grain which has passed through the bed in that interval. The author has shown that the moisture content of wheat can be reduced to storage value under average harvest conditions in a single-stage contra-flow grain-dryer using a bed depth of 1¾ ft.

A design for a contra-flow dryer using electric heating and suitable for a small grain producer is shown in Fig. 4. Damp grain is elevated into a hopper (1) and flows by gravity into the cylinder (2) which is completely filled with grain. The rate of grain flow through the cylinder is regulated by the rate of removal at (3). Air is supplied by a fan (4) and is heated electrically (5). The air flows upwards through the bed of wheat (6) and is returned (7) at a high relative humidity to the atmosphere. Some of the air supplied by the fan is tapped off (8) before it reaches the heater and is blown through the dried grain to cool it and remove any moisture which may have sweated to the surface in zone (9).

POTATO STORAGE

Indoor storage of potatoes has the following practical advantages: 1. Potatoes are available for marketing in all weathers. 2. Sorting and bagging can be carried out in good working conditions. De Jung[6] in Holland has shown that the ideal storage temperature for potatoes is 35 to 40 deg. F. Potatoes in a clamp respire and produce heat as shown in Fig. 5. To achieve a temperature of 35 to 40 deg. F., the potatoes must be cooled when they are placed in the store and the metabolic heat must be removed afterwards. On the Continent cold atmospheric air is blown through the clamp of potatoes to cool them. Where air near freezing point is available for long periods, a small capacity fan is sufficient and very often grain-drying plants can be used to force air through ducts placed beneath the potatoes as shown in Fig. 6.

In Ireland, because of its milder winter climate, there are not many hours every day when the air temperature is near freezing point. An analysis of the meteorological records for the storage periods of two years is shown in Fig. 7. Better storage than we have at present in unventilated clamps could be obtained if the cold hours were used to ventilate the store. The hours of low air temperature, which are available, can, of course, be used most effectively to cool the potatoes by a high capacity fan controlled by a thermostat which measures the temperature difference between the potatoes and the atmosphere. Burton[7] has used natural circulation of the air during the winter months in England to cool potatoes in a similar type of store to that used for forced ventilation. In a clamp 6 ft. high, the average temperature of the potatoes was 5 deg. F. above the mean temperature of the store during the middle of the storage season.

The quantity of heat removed per square foot by natural circulation of the air (calculated according to the method described in Appendix I) through a clamp of potatoes 6 ft. high at an average temperature of 45 to 50 deg. F. is shown in Fig. 8, T_{AV} being the average temperature of the potatoes and T_1 the ambient temperature. The quantity of heat removed by a fan delivering 10 cub. ft. of air per sq. ft. per min. through the same stack is shown for comparison. Under Irish conditions it is impossible to cool potatoes to 35 to 40 deg. F. by natural ventilation, but the metabolic heat could be removed during the colder months in a store designed to keep pressure losses small and with roof ventilators to assist the natural draught. If the store is partially located below ground level, it will improve the insulation and reduce the circulation of air when the atmospheric temperature is greater than the clamp temperature.

GRASS CONSERVATION

Grass conservation to provide bulk feeding for animals during the winter may be carried out in two general ways—hay making and ensilage. At cutting, the moisture content of the grass may be as high as 80 per cent. For storage of hay in cocks the moisture content must be reduced to 30 per cent.; for baling to 25 per cent.; and to 20 per cent. before placing in a large stack. In good drying conditions in Ireland grass can be dried on the ground to 30 per cent. in three days; in bad weather it may take three or more weeks. Examination of weather reports shows the low incidence of three rain-free days. After drying to 60 per cent. moisture content hay may be placed on racks where the drying can be completed safely but slowly. Drying on racks cannot be readily mechanised but is a cheap, safe method for small farmers. Barn-hay drying has been used to complete the drying of hay from about 40 per cent. to 20 per cent., by ventilating the hay in a layer 4 to 6 ft. thick with air heated to about 20 deg. F. above ambient. Such units, however, are comparatively small and the drying cost in an oil-fired plant is about £3 per ton[8].

During hay making on the ground, losses of feeding

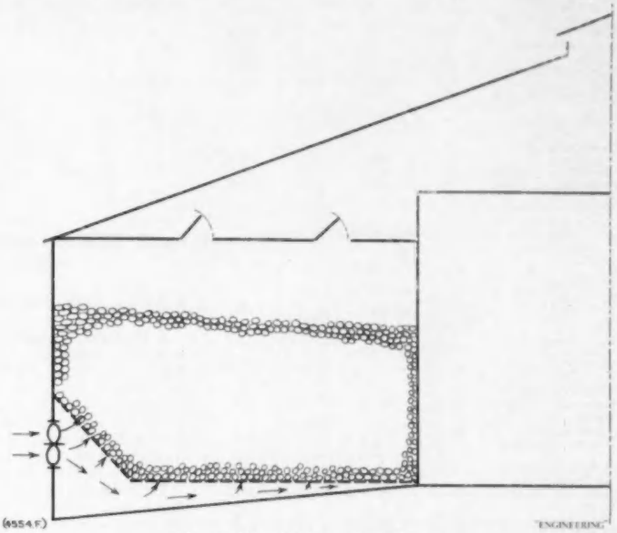


Fig. 6 Ventilated potato store.

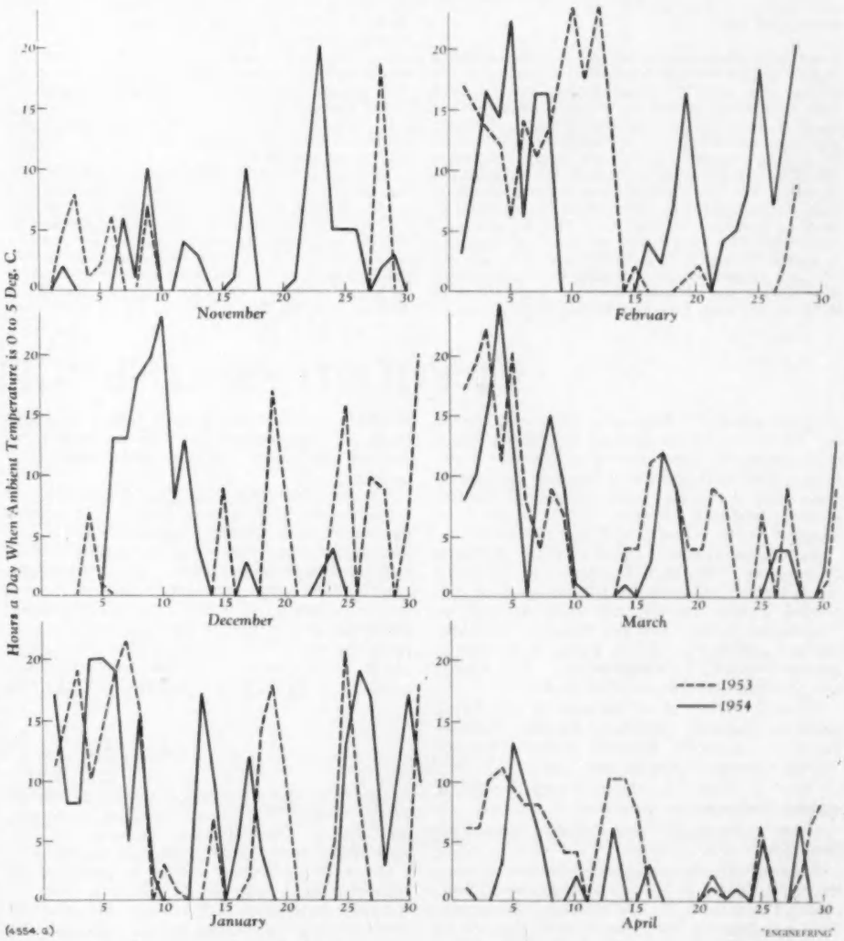


Fig. 7 Distribution of ambient temperatures suitable for potato storage in Ireland.

Continuing Production

TABLE I.—*Survey of Ensilage Methods in the Netherlands*

	Number of samples	Percentage of samples		
		Good	Fair	Failed
Not Mechanically Mixed				
Grass without addition	354	8·8	9·1	82·1
Grass with raw potatoes	58	6·8	6·9	76·3
Grass with mangolds	217	37·4	27·7	34·9
Grass with molasses	754	29·7	26·6	45·7
Grass with AIV acid	208	55·9	17·3	26·8
Mechanically Mixed				
Grass with raw potatoes	26	30·8	10·2	59·0
Grass with mangolds	583	62·8	17·5	19·7
Grass with molasses	97	64·0	28·9	7·1

TABLE II.—*Survey of Ensilage Methods in Sweden*

	Dry matter, per cent.	Loss of		*p*H
		Organic substances, per cent.	Crude protein, per cent.	
Without Addition				
Tower silo (chopped)	25·61	22·53	22·49	4·4
Tower silo (unchopped)	26·96	24·39	20·11	4·8
Pit silo (unchopped)	26·04	29·23	27·67	4·9
With Addition of Crushed Oats				
Tower silo (chopped)	29·16	10·86	2·50	4·3
Tower silo (unchopped)	26·53	14·02	8·07	4·6
Pit silo (chopped)*	26·24	18·15	11·69	4·3

* Silo was covered with silo paper, 15 cm. sawdust and 20 cm. clay. Wastage from surface was 1·3 per cent. of the final weight taken out.

value take place by respiration, leaching, bacteria and mould growth and mechanical shattering of the leaves. The different stages in hay making have been mechanised but without any significant improvement in the quality of the final product. Ensilage can be a much more reliable method of conservation in a damp climate as it depends on a fermentation which is not influenced noticeably by the moisture content. Two principles of silage making have been used in the past: 1. compaction of the material to produce anaerobic respiration of the cells and form lactic acid (the temperature in the silage may rise to above 100 deg. F.); 2. chopping of the grass and addition of molasses, mineral acids or metabisulphite to stimulate the conservation. The first method is more widely used than the second, largely because

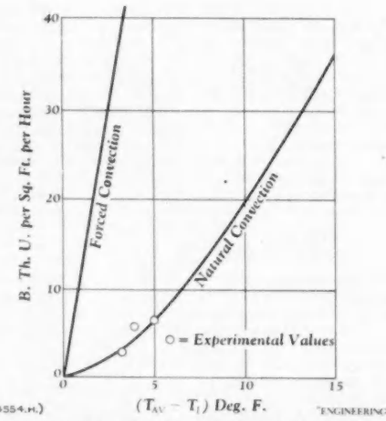


Fig. 8 Heat removed by air convection through a clamp of potatoes.

it is convenient to organise and cheap in the actual cost of ensiling the grass.

A survey of the different methods was carried out in the Netherlands.[9] It was based on samples taken from the farmers' own silos. The results are shown in Table I, where the silages have been classified on a basis of *p*H value—less than 4·2 is good; 4·3 to 4·5 is fair and higher than 4·5 is failed. Similar results, which have been obtained in Sweden[10] in experiments to compare ensilage in towers and pits, are shown in Table II.

Research workers have shown for about 20 years that a good conservation can be obtained by chopping the grass and using an additive to stimulate the fermentation. In practice their advice has not been widely followed because of difficulties in collecting the grass to feed stationary chopping-machines. With the development of the forage harvester, the whole outlook for silage making has changed, for it allows the process of grass conservation to be fully mechanised with a consequent reduction in labour. The forage harvester can cut the grass or pick up wilted material from a windrow, chop it and blow it into a trailer. At the silo, the chopped material can be blown from the trailer, mixed with an additive and blown into the silo.

On large farms, grass conservation and feeding can be completely mechanised by using a forage harvester with large tower silos from which the silage is later removed by mechanical cutters which convey it to feeding tables for the cattle. On smaller farms a similar system of silage making may be used with pits, which must be lined with concrete and roofed to reduce wastage. Such pits allow the animals to feed at the silage and reduce the labour required in removing it manually from a small tower; grass conservation with self-feeding of silage is seen to full advantage in a loose system of cow-housing.

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APPENDIX I.—Calculation of Heat Removal from Potatoes by Natural Convection.

Assumptions:—

(i) Average temperature of potatoes in stack = 2/3 maximum temperature.

(ii) Air leaves the stack at the maximum temperature of the potatoes.

(iii) Pressure loss in the potatoes can be expressed in the form[7] $P = KV^{1\cdot8}$

where P = pressure drop, in. w.g., per ft. of stack height

$K = 2\cdot7 \times 10^{-4}$

V = velocity of flow based on whole cross-sectional area of stack (ft. per min.)

(iv) Heat loss by conduction is negligible.

Pressure difference per foot of stack height

$$= 0\cdot19\, w_1 \frac{T_2 - T_1}{T_1} \text{ in. w.g.}$$

where T_2 = average temperature of potatoes (deg. R.)

T_1 = ambient air temperature (deg. R.)

w_1 = specific weight of air.

$$V = \left\{ \frac{0\cdot19\, w_1}{K} \frac{(T_2 - T_1)}{T_1} \right\}^{0\cdot555}$$

Heat removed from stack per sq. ft. per hour

$$Q = 14\cdot4\, V\, (T_3 - T_1) \text{ B.Th.U.}$$

The quantities of heat which were removed by natural convection from a stack of potatoes have been measured by Burton.[7] These values are compared with those given by the above method of calculation in Fig. 8.

CERTIFIED EXPLOSION PROOF

Motors labelled "Explosion proof—approved by American Underwriters Laboratories Inc." were among the components exhibited by Newman Industries at the recent Engineering Exhibition. The procedure for obtaining Underwriters' approval follows very closely that adopted by the Ministry of Power at Buxton.

Buxton certified motors are referred to in this country as "flameproof" and the Newman machines are approved for gas groups I, II, III. Similar motors are referred to in America as "explosion proof" and the Newman machines are now certified for class 1, group D and class 2, groups F and G, by Underwriters. The American classified hazardous locations are:

Class 1, *Group D.*—Atmospheres containing gasoline, hexane, naphtha, benzine, butane, propane, alcohols, acetone, benzol, lacquer solvent vapours or natural gas.

Class 2, *Group F.*—Atmospheres containing carbon black, coal or coke dust.

Class 2, *Group G.*—Atmospheres containing flour starch or grain dusts.

Although there are marked similarities between the requirements of the two authorities—in both cases all joint faces are 1 in. wide and the permissible gap between the faces is small enough to provide an effective flame trap—there are differences that normally mean that a motor that satisfies Buxton requirements will not satisfy those of Underwriters. In addition there is no Buxton equivalent for the inflammable dust groups.

The procedure for obtaining the approval of Underwriters Laboratories is to first submit drawings for preliminary examination. Completed motors are then subjected to tests in both inflammable gases and dusts. When these have been satisfactorily completed the motors are listed as approved. However, Underwriters' certificate of approval to manufacture is not, in itself, the end. Every motor built to the requirements is inspected by an Underwriters' representative in Great Britain before it can be fitted with a serially-numbered approval plate and despatched. In addition to the individual inspection of motors before despatch, Newmans Industries Limited, Yate, Bristol, receive a twice-yearly visit from an Underwriters representative from the United States who checks that the routine inspection procedure is being properly followed.

The production of these motors now puts Newman into the position of being able to offer a range of motors, ½ to 30 h.p., designed electrically to meet either British or NEMA standards, and mechanically interchangeable in drip-proof, totally enclosed, flameproof, or explosion proof, enclosures.

HESSIAN BIAS TUBING

A new high-speed packaging material, "Quick Wrap" hessian bias tubing, has been introduced by the Quick Wrap Tubing Company, Limited, Jute Mills, Bow Common-lane, London, E.3.

Quick Wrap hessian tubing is produced in rolls of hessian sewn on the bias into tubes of varying dimensions (eleven in all) and of approximately 160 yards length. Through the use of the tubing, cutting and measuring is eliminated. All the packer has to do is to select the appropriate size tube, pull it over the package, tie both ends with a wire tie and cut with a sharp instrument the end still attached to the roll. The tubing stretches and moulds itself to the product closely, so that there is an approximate saving of about 33 per cent. of hessian on every package used. The tubes roll off as easily as they roll on, and can be used again. Stencilling is carried out in the same manner as with ordinary hessian.

Atomic Review

Marine Comparison

CHOOSING the best reactor for a given job has all the interest of picking the ideal English team. In Atomic Review on October 4, we published parts of Dr. T. W. F. Brown's De Laval Memorial Lecture, in which reference was made to the selection of nuclear reactors for marine propulsion. To-day we continue our summary of Dr. Brown's lecture, and give a detailed comparison of three reactors showing promise for sea-going applications. The previous article was a more general survey of five reactor systems, dealing also with fuel enrichment and shielding—problems of special significance for marine reactors. Unfortunately, in our paragraph on the gas-cooled graphite-moderated reactor the word "low" was omitted. The final sentence should of course have read: The size of gas-cooled graphite-moderated reactors decreases markedly when even low fuel enrichment is used.

Merchant Ship Nuclear Plants Now Building

Only two marine reactor installations are believed at present to be under construction in the world for merchant ships, and both are of the pressurised-water reactor type. The first is the United States *Atoms for Peace* ship which is mixed passenger and cargo with a speed of 21 knots, length b.p. 587 ft., beam 78 ft., and draught 29½ ft. The machinery installation gives 20,000 s.h.p. normal service and 22,000 s.h.p. overload. The pressurised-water reactor has 2·9 per cent. enrichment. The second is the Soviet icebreaker, which is 525 ft. long b.p. by 82 ft. beam, having a displacement of 25,000 tons gross. This ship is now constructed as far as the deck plating and the propulsion turbines and generators are reported as completed at the Sergei Kirov and Electrosila works in Leningrad. The reactor, which is of pressurised-water type, has 200 MW heat output of which 100 MW is taken to the propulsion turbo-generators. The generators give a peak power of 60 MW, with 40 MW transmitted to the propulsion motors (say 49,000 s.h.p. total on four shafts allowing for losses). The reactor is fitted between the turbo-generator room and the aft main propulsion motors. It is stated that 78 kg. of fuel will be consumed per year, the equivalent of 150,000 metric tons of fuel oil.

Reactor Criteria

An attempt has been made to assess the relative sizes and technical particulars for three types of reactor which are considered practicable for merchant marine nuclear propulsion plant. The types examined are: (*a*) Calder Hall type with graphite moderation and gas cooling; an examination is made of the effect enrichment has on size; (*b*) reactors of pressurised-water type, in which enrichment is essential; and (*c*) a possible heavy-water moderated gas-cooled reactor using natural uranium.

Vessel Criteria

All the reactors have been worked out to give 22,000 s.h.p. net power at the shaft for a 60,000 ton deadweight tanker. This size was chosen for examination as several are on order; the steam turbine designs have been roughed out and the ship's lines were available to enable an engine layout to be prepared. The ship sizes are: l.o.a. 790 ft., l.b.p., 750 ft., beam 107 ft., depth 57 ft., and draught 42 ft. The maximum bunker capacity is 5,000 tons, but may be reduced to 3,000 tons. (For smaller tankers bunker capacity is about 9 per cent. of the deadweight.) The conventional steam-turbine propulsion machinery has boilers fired with hydrocarbon fuel. The machinery has a normal service power of 22,000 s.h.p., a maximum service power of 25,000 s.h.p., a pressure at superheater outlet of 650 lb. per sq. in. gauge, and temperature 950 deg. F. The vacuum is 28·5 in. The speed of the high-pressure turbine is 4,200 r.p.m. and of the low-pressure turbine 3,100 r.p.m.; the speed of the main shaft is 105 r.p.m. The nonbled steam rate is 5·55 lb. per s.h.p. hour.

Graphite-Moderated Reactors

Table I gives the sizes for marine reactors based on Calder Hall with increasing enrichment up to 2 C_0 (1 C_0 is the concentration of uranium 235 in natural uranium). This enrichment is considered the maximum at present as the rating has risen to more than 8 MW per tonne. Fig. 1 shows a gas-cooled graphite-moderated propulsion unit.

Pressurised-Water Reactors

Table II lists the main particulars for the Shippingport and Yankee reactors and gives two designs for merchant ship pressurised-water reactors for 22,000 s.h.p. and 10,000 s.h.p. output at the shaft with the minimum enrich-

TABLE I.—*Data for Uranium Graphite-Moderated Gas-Cooled Reactors*

	Nat. U	1·27 C_0	1·54 C_0	2·0 C_0
Heat output, MW	68·5	68·5	68·5	68·5
Net output, s.h.p.	22,000	22,000	22,000	22,000
Cycle efficiency, per cent.	24	24	24	24
Weight of uranium (tonnes)	65	28	16	8
Weight of graphite (tonnes)	300	130	75	37
Rating, MW per tonne	1·05	2·45	4·3	8·6
Reflector, ft.	3	3	2·75	2·5
Core diameter, ft.	20	15	12·5	10
Core height, ft.	20	15	12·5	10
Pressure vessel diameter, ft.	26·5	21·5	18·5	15·5
Pressure vessel height, ft.	64	40	36	30
Pressure vessel thickness, in.	3	3	3	4
Coolant gas pressure (CO_2), lb. per sq. in. g.	200	270	300	450
Coolant gas temperature, inlet, deg. F.	460	460	460	460
Coolant gas temperature, outlet, deg. F.	680	680	680	680
Gas quantities, lb. per sec.	1,160	1,150	1,145	1,136
Gas circulator power, kW	1,000	920	850	720
Steam pressure, lb. per sq. in. g.	460	460	460	460
Steam temperature, deg. F.	650	650	650	650
6 in. steel thermal shield + 7 ft. concrete shielding, tons	6,742	4,102	3,272	2,486
Composite shielding, tons	4,800	3,300	2,500	2,000
Total reactor weight, tons	674	327	227	168
Heat exchanger and piping system, including blower, tons	270	314	332	426

Notes to Table I:

(1) Fuel rods just over 1 in. diameter, pitch about 8 in., optimised for minimum critical size and maximum conversion factor.

(2) C_0 value	1	1·5	2·0	2·5	3·0	3·5	4·0
Percentage uranium 235 by weight	(Nat. U) 0·72	1·08	1·44	1·80	2·16	2·52	2·90

(3) The maximum reactivity of the natural uranium system cannot exceed 0·08 and the core is therefore inherently large.
(4) Critical size takes account of the high purity of graphite now available. If slightly under-estimated for natural uranium a very small amount of enrichment would correct.
(5) The rating is low compared with the civil reactors, and although this is undesirable economically, low flux and low heat transfer rates across fuel elements permit high coolant temperatures and better steam conditions from the heat exchangers.
(6) Pumping power varies as $\frac{1}{P^3 \Delta T^2}$ hence any decrease in ΔT requires a large increase in pumping power; where ΔT is temperature rise through reactor, and P is absolute pressure.
(7) The pumping power could be reduced by a factor of about 6 if hydrogen were used but this gas permeates the canning material at high temperatures and interacts with uranium, leading to burst fuel elements. It has therefore been ruled out in this preliminary investigation using Magnox canning materials. Helium and carbon dioxide are nearly equal and as helium is much more expensive, carbon-dioxide cooling has been adopted for these designs.
(8) The rating in the 2 C_0 reactor is too high and would introduce heat-transfer difficulties but it is included to show the limit of enrichment required at present.

TABLE II.—*Data for Pressurised-Water Reactors*

	Shippingport	Yankee	22,000 s.h.p. design	10,000 s.h.p.
Heat output, MW	230	480	71	36
Net output	60 MW (3 loops)	134 MW	22,000 s.h.p.	10,000 s.h.p.
Cycle efficiency, per cent.	26	27·8	23	21
Weight of uranium	12 tons	27 tonnes	30 tonnes	8 tonnes
Enrichment	Nat. UO_2 52 kg. of U235 alloyed with zirconium	UO_2 pellets 2·6 per cent.	Nat. U 1·5 C_0†	Nat. UO_2 4 C_0
Rating MW per tonne	19	17·5	2·35	4·5
Core diameter, ft.	6	6·16	5·5	4
Core height, ft.	6	8·33	5·5	6
Pressure vessel diameter, ft.	9	9·08	7·5	6
Pressure vessel height, int. ft.	33	32·5	26	25
Pressure vessel thickness, in.	8·5	8	7	6·5
Moderator and coolant pressure, p.s.i.g.	2,000	2,000	2,000	2,000
Water flow temperature, inlet, deg. F.	508	487	520	520
Water flow temperature, outlet, deg. F.	542	529*	556	556
Water flow quantity, lb. per hr.	27×10^6	37×10^6	$5{\cdot}5 \times 10^6$	$3{\cdot}5 \times 10^6$
Pressure drop, p.s.i.	105 (main coolant loops)	25 (through reactor)	100 (main coolant loops)	100
Water circulating pumps	—	—	1,070 net h.p.	590 h.p.
Steam conditions dry sat., p.s.i.g.	600	521	560	560
Vol. ratio $\frac{\text{water}}{\text{equiv. uranium}}$	—	2·8	1·5	1·1
Conversion factor	—	—	0·65	0·60
6 in. steel thermal shield + 7 ft. concrete shielding, tons	—	—	1,350	1,200
Composite shielding, tons	—	—	1,000	860
Total reactor weight, tons	250	250	137	40
Heat exchanger and piping system, including blower, tons	—	—	162	90

Notes to Table II:

* (1) Water in hot channel 628 deg. F. giving 8 deg. F. margin against bulk boiling.
(2) Both United States reactors rated at 8,000 MW days of heat per ton before refuelling. Core life 10,000 hours.
(3) Containment vessel is essential (for Yankee designed for 36 lb. per sq. in. gauge).
(4) Operation of PWR's possible with failed fuel elements.
† (5) Low enrichment is only possible if materials giving high neutron economy such as magnesium, aluminium and zirconium are employed inside the reactor.
(6) United States claim that great increase in rating of PWR possible, for example in the United States Atomic Energy Commission sponsored study, Project Dynamo; it was felt that ultimately the attainment of higher heat fluxes should be possible with a 30 per cent. safety factor, due to the good heat transmission rates with water cooling.

	PWR Shippingport	PWR Dynamo
Maximum BHU per sq. ft. per hr.	380,000	1,000,000
Average, blanket	65,000	270,000
seed	112,000	270,000

Continuing **Atomic Review**

TABLE III.—*Data for Natural-Uranium Heavy-Water Moderated Gas-Cooled Reactor*

Heat output	77 MW (including 7 per cent. reactor heat to moderator)	
Net output	22,000 s.h.p.	
Cycle efficiency	21·2 per cent.	
Weight of natural uranium	12·0 tonnes	
Weight of deuterium	19 tonnes	
Rating	6·5 MW per tonne	
Reflector	18 in. graphite, 4 in. heavy water	
Core diameter	8 ft.	
Core height	11 ft.	
Pressure vessel diameter	14·5 ft.	
Pressure vessel height	28 ft.	
Pressure vessel thickness	4 in.	
Coolant gas pressure	CO_2 at 400 p.s.i.	
	Magnox cans	Beryllium cans
Coolant gas temperature, inlet	375 deg. F.	400 deg. F.
Coolant gas temperature, outlet	800 deg. F.	950 deg. F.
Gas quantities	620 lb. per second	
Gas circulator power	1·6 MW	
Steam pressure	400 per sq. in. gauge	
Steam temperature	750 deg. F.	
Moderator	Heavy water maintained at 80 deg. C. and externally pressurised by helium to prevent dissolving CO_2 which involves small cooler circuit and pressurising tank	
6 in. steel thermal shield + 7 ft. concrete shielding	2,400 tons	
Composite shielding	1,800 tons	
Total reactor weight	141 tons	
Heat exchanger and piping system, including blower	394 tons	

Notes to Table III:

(1) The moderator absorbs 7 per cent. of the reactor heat and a main problem is to maintain it at a low temperature; this requires a low coolant inlet temperature, which is a disadvantage from the steam-cycle consideration.

(2) There would not appear to be any incentive to use high enrichments with heavy water moderation as even with natural uranium excess reactivity is quite high, $k_\infty = 1{\cdot}207$ (compared with Calder Hall, $k_\infty = 1{\cdot}065$). This reactor involves a considerable amount of structural material with both the calandria and shielding tubes. This might upset the neutron balance and require the use of slight enrichment. In fact, if enriched uranium were available at reasonable cost, this reactor development would not be required.

(3) Direct loss of about 7 per cent. of reactor heat to moderator giving a relatively low cycle efficiency compared with that possible from steam conditions.

(4) Using a heat exchanger to remove nuclear heat generated in moderator requires control of the moderator flows in the reactor vessel to ensure uniformity. Turbulence would cause variation in reactivity which would have a serious effect on control.

(5) Operation of a heavy-water reactor requires extreme care to prevent loss or contamination of this expensive fluid (£20,000 per tonne).

(6) High conversion ratios (over 1·0 possible).

(7) It is desirable to keep the bypass of main gas flow between the baffle tube and the calandria tube small since this results in the lowest calandria tube temperatures and the least heat loss to the moderator. The dilution of the main gas flow by the cooler bypass flow will also be a minimum.

ments considered necessary for the duty. The 22,000 s.h.p. reactor could also operate at nearly double the rating (hence of course for half the time with a given charge) with increased cooling flows and changes in the heat exchangers. The smaller output reactor is included mainly to emphasise the increase in enrichment required to reduce core sizes and hence the reactor sizes for small outputs where neutron economy is difficult to achieve in a thermal reactor.

Heavy Water Reactor with Gas Cooling

In Table III (left) particulars for a projected design of reactor, heavy-water moderated and gas cooled using natural uranium, are given. A drawing published in Atomic Review on October 4 illustrated the layout of this reactor.

Engine-Room Weights

Table IV (below) compares plant weight for the three types of reactor and an oil burning installation.

Engine-Room Arrangements

Fig. 2 is a sketch of an engine-room layout of 22,000 s.h.p. for the 60,000 ton tanker, and summarises Dr. Brown's conclusions. There is plenty of room for the reactor control panel on the boiler shelf. As may be seen, the Calder Hall type of reactor, although of minimum core diameter, projects through the upper deck, and while this may be convenient for fuel servicing and the like, it is clearly not good for the structure. The enriched-uranium reactors, graphite moderated or PWR or water-moderated gas-cooled reactors, however, can be housed below the upper deck, producing a stronger ship. The aft bulkhead of the reactors would normally be the forward engine-room bulkhead for conventional steam-turbine machinery as the propulsion boilers can easily be accommodated on the boiler flat aft of the turbines. The extra engine-room length is, however, to some extent compensated for by the great reduction in bunker space.

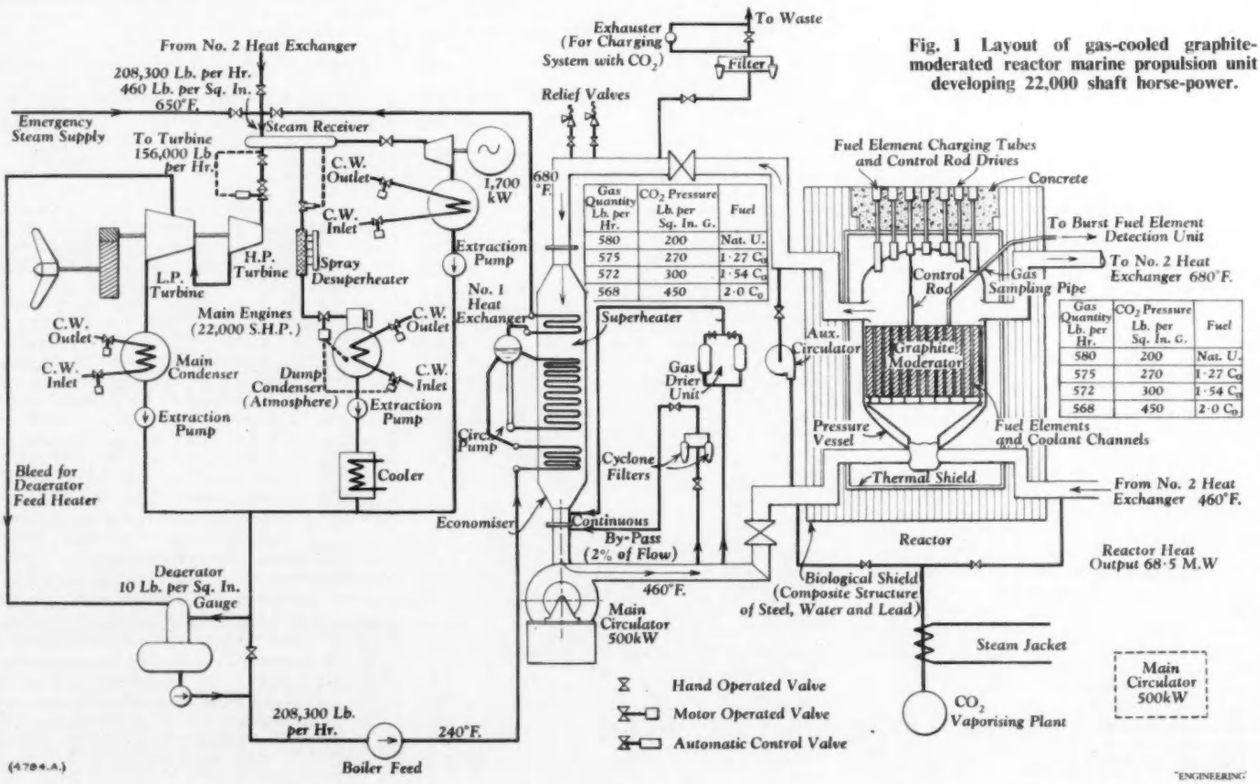
Costs

A detailed analysis of costs for the heavy-water moderated gas-cooled reactor is not possible, but Dr. Brown in his lecture gave tables comparing costs for gas-cooled graphite-moderated and pressurised-water reactors.

It is also worth examining the cost of fuel per s.h.p. for a 44,000 s.h.p. installation. Both reactors will work at twice the rating with very minor changes and consequently the increased capital charges will be materially reduced on a horse-power basis. It will be seen how heavily the capital cost weights the fuel expenditure figures on a cost per s.h.p. per hour basis, although refuelling has to be carried out twice as frequently for twice the horse-power. To

TABLE IV.—*Turbine and Complete Engine-Room Weights (Steam up) for 22,000 s.h.p. Installation*

Weight in tons	Oil burning installation, 650 p.s.i.g., 950 deg. F.	Graphite moderator, gas cooled 460 p.s.i.g., 650 deg. F.				PWR system, 560 p.s.i.g. sat.	Al-D_2O-U system, 400 p.s.i.g., 750 deg. F.
		Enrichment					
		Nat.	1·27 C_0	1·54 C_0	2·0 C_0		
High-pressure ahead and astern turbine	9·5	9·3				10·9	8·5
Low-pressure ahead and astern turbine	33·0	42·0				43·5	43·0
Condensers	48·0	59·0				69·0	54·0
Gearing (fabricated)	100·0	100·0				100·0	100·0
Main engine weight	190·5	210·3				223·4	205·5
Total Machinery weight (steam up)	1,560	7,015	5,212	4,330	3,870	2,590	3,610
Bunkers (1) normal	3,000						
(2) cargo working in emergency only		800	800	800	800	800	800
Total weight (machinery plus fuel)	4,560	7,815	6,012	5,130	4,670	3,390	4,410
Resultant excess weight	—	3,255	1,452	570	40	—	—
(Tons) or saving in weight of nuclear propulsion machinery	—	—	—	—	—	1,170	150



Gas Quantity Lb. per Hr.	CO_2 Pressure Lb. per Sq. In. G.	Fuel
580	200	Nat. U.
575	270	1·27 C_0
572	300	1·54 C_0
568	450	2·0 C_0

Gas Quantity Lb. per Hr.	CO_2 Pressure Lb. per Sq. In. G.	Fuel
580	200	Nat. U.
575	270	1·27 C_0
572	300	1·54 C_0
568	450	2·0 C_0

Fig. 1 Layout of gas-cooled graphite-moderated reactor marine propulsion unit developing 22,000 shaft horse-power.

take advantage of the higher horse-power, ship dimensions would have to be increased with an increase in overall capital charges to be offset against increased earnings arising from the higher speed of the ship. The figures, while very rough, are useful in showing trends. At this very early stage of development in marine reactors, the prospects of reducing additional capital costs are good.

TABLE V.—*Costs for 22,000 s.h.p. Nuclear Installation*

Reactor type	Natural-uranium graphite-moderated gas-cooled		PWR enriched fuel	
Cost of fuel charge	£1,300,000		£1,230,000	
Cost of moderator	£120,000		—	
Rating $\frac{MW}{tonne}$	1·05		2·35	
Days before refuelling	2,860		1,620	
Running cost on fuel per s.h.p.-hr. in pence	0·23		0·35	
13 per cent. per annum on increased capital cost per s.h.p.-hr. in pence[1]	0·51		0·30	
6 per cent. interest on fuel investment per s.h.p.-hr. in pence	0·12		0·11	
Gross cost pence per s.h.p.-hr.	0·86		0·76	
	(*a*)	(*b*)	(*a*)	(*b*)
Credit for Pu and spent fuel in pence per s.h.p.-hr.[2]	0·13	0·25	0·09	0·18
Net fuel cost, pence s.h.p.-hr.	0·73	0·61	0·67	0·58

[1] Increased capital charges per year = £332,000 and £195,000. Taking 81 per cent. usage as reported for 38,000 ton tankers, then the average horse-power per year = 22,000 × 0·81 = 17,800 s.h.p.

[2] Credit for plutonium alternatively:
(*a*) £5 per gm. nett of processing cost.
(*b*) £10 per gm. nett of processing cost.

TABLE VI.—*Costs for 44,000 s.h.p. Nuclear Installation*

Reactor type	Natural-uranium graphite-moderated gas-cooled		PWR enriched fuel	
Cost of fuel charge	£1,300,000		£1,230,000	
Cost of moderator	£120,000		—	
Rating $\frac{MW}{tonne}$	2·1		4·7	
Days before refuelling	1,430		810	
Running cost on fuel per s.h.p.-hr. in pence	0·23		0·35	
13 per cent. per annum on increased capital cost per s.h.p.-hr. in pence	0·25		0·15	
6 per cent. interest on fuel investment per s.h.p.-hr. in pence	0·06		0·05	
Gross cost, pence per s.h.p.-hr.	0·54		0·55	
	(*a*)	(*b*)	(*a*)	(*b*)
Credit for Pu and spent fuel in pence per s.h.p.-hr.	0·13	0·25	0·09	0·18
Net fuel cost, pence s.h.p.-hr.	0·41	0·29	0·46	0·37

Prospect

Much has to be done, but the whole object of this outline survey is to show the feasibility of nuclear propulsion of merchant ships starting with a tanker (except for war vessels or very high powered passenger vessels it would appear that only one reactor per ship should be provided). Enriched fuel (up to a maximum of say 4 C_0) is clearly of supreme importance to the future of mercantile marine reactors, whether graphite or water moderated. Failing this the development of the heavy-water moderated gas-cooled reactor should be pressed forward urgently, although it introduces many new problems of its own. In the future, fast breeder reactors will be necessary, as they will extend the use of uranium by a factor of more than 100 and are by far the best means of using plutonium. When temperatures of the cooling gas exceed 1,200 deg. F., the possibility will arise of utilising the gas turbine, which has already been developed for use at this temperature, and which is being further developed for use with gas temperatures up to 2,200 deg. F. Still further in time, power from thermonuclear fusion of light elements may be possible in which case a ship is floating on an unlimited store of deuterium ($3{\cdot}8 \times 10^{18}$ tons in the oceans of the world). If the energy in hydrocarbon fuel reserves is represented by 1 mm., the energy available from the fussion of light elements corresponds to 100 km. Future costs for nuclear propulsion will be much lower than those arising from the burning of hydrocarbon fuels, which will become scarcer and much more expensive with the passage of time.

General Notes

Homogeneous PWR

A reactor suitable for shipboard—or submarine—use is the homogeneous pressurised-water system. Though the reactor is fundamentally a simple pressurised-water design, the solid fuel elements are of sufficiently small diameter and so numerous that nuclear calculations can be made as if the reactor core were homogeneous. It is of related interest that a low-energy experimental prototype would not need to be pressurised since the temperature of the water would not be raised significantly. It has been reported that corrosion in the Nautilus submarine PWR has been less marked than expected.

Extension to Radiochemical Centre

New buildings at the Radiochemical Centre, Amersham, are being opened on November 1 by Lord Salisbury. The extensions have been made necessary by the increasing scope of the Centre's work and the rapidly growing world-wide demand for its products. The buildings incorporate interesting architectural features and new methods for handling radioactive materials.

OMRE Starts Up

The Organic Moderated Reactor Experiment (OMRE), developed for the United States Atomic Energy Commission by Atomics International, a division of North American Aviation, has begun operating at the Commission's National Reactor Testing Station in Idaho. Operation of the reactor began when a self-sustaining nuclear reaction was achieved on September 17, 1957. OMRE is said to be the first nuclear reactor of this type to go into operation. The reactor uses an organic fluid, a carbon-hydrogen compound called terphenyl, for the dual rôle of moderator-coolant. About 16 MW of heat will be produced when full power is attained.

PLUTO Starts Up

PLUTO, the latest materials testing reactor at the Atomic Energy Research Establishment, Harwell, went into operation at 7.50 p.m. on Friday, October 25, 1957. At full power PLUTO will generate a peak neutron flux of 10^{14} neutrons per sq. cm. per sec. at a heat output of 10 MW. It is similar in design to the DIDO materials testing reactor, but there are fewer holes into the PLUTO core since these are primarily designed for large-scale engineering loop systems. The reactor and its associated plant and buildings was designed and constructed by an Atomic Energy Research Establishment team in association with the Ministry of Works and Head Wrightson Processes Limited.

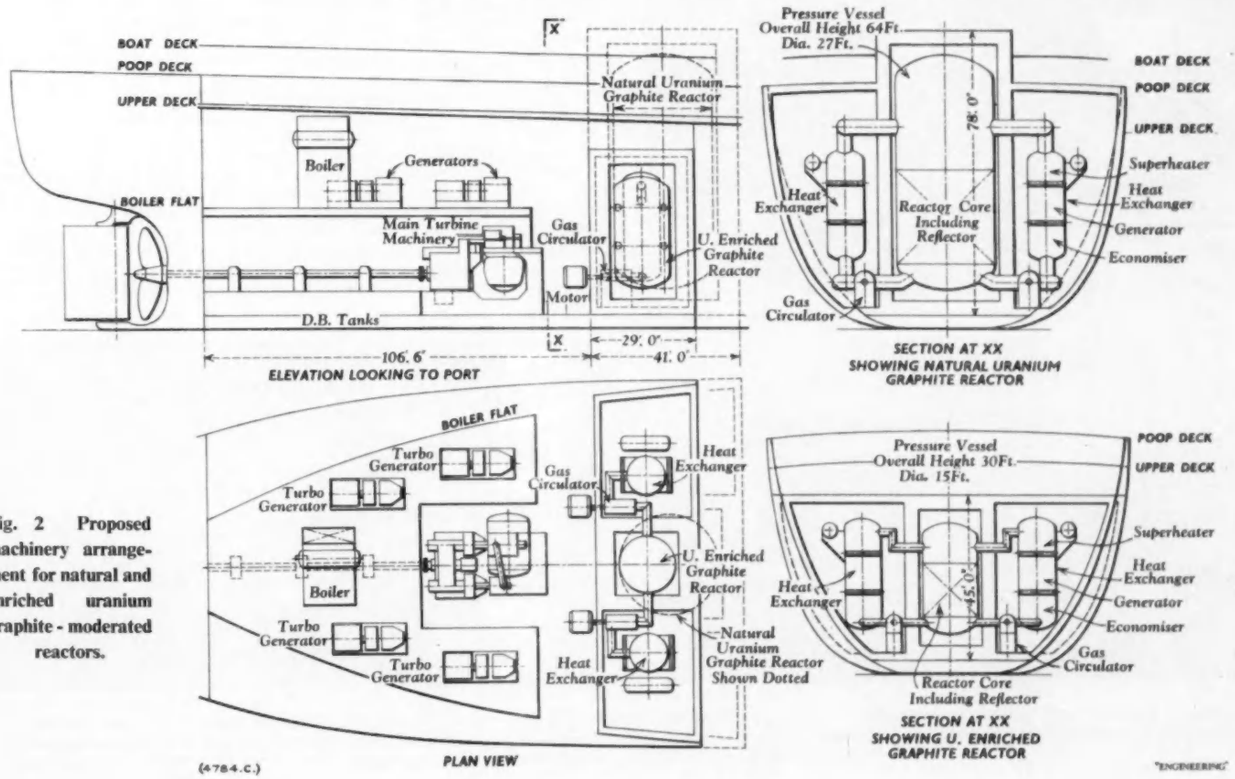


Fig. 2 Proposed machinery arrangement for natural and enriched uranium graphite - moderated reactors.

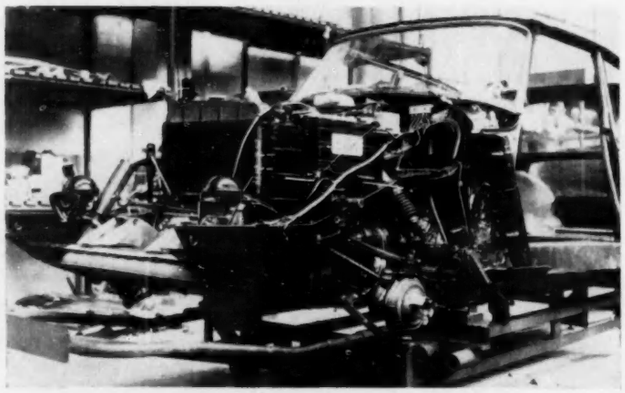
Automobile Engineering

DESIGN TRENDS AT RECENT MOTOR SHOWS

By Gordon Wilkins

Current European models exhibit two totally opposed schools of car structure design, and the question of which will ultimately prevail is of interest to engineers, to car owners and insurance companies. Long experience with unit body-chassis structures has enabled the two General Motors subsidiaries, Vauxhall and Opel, to bring out new models, with greatly increased seating capacity, and a large increase in glass area, at a negligible weight increase over the models they replace. This has been done partly by incorporating every possible part of the external sheet metal, roof, and wings especially, as a permanent stress-carrying surface. The pillars supporting the roof are extremely slim, but the glass itself contributes usefully to the general stiffness. At the opposite extreme is the Citroen DS19, which has a punt base, and scuttle structure, with the minimum necessary pillars, supporting a light frame to which a plastics roof panel is attached. Every piece of exterior panelling is detachable. In particular, repair of the wings is facilitated by the fact that they can be withdrawn by undoing one nut with the wheelbrace, whereas it becomes a surgical operation on the unit construction cars. Clearly the Citroen method offers the possibility of a reduction in repair costs, and it also permits periodical style changes without alteration of the basic structure, but unit construction may offer better protection to the occupants in the event of the car rolling over even with the slim pillars employed to-day.

The station wagon is rapidly gaining in popularity and designers are stressing comfort and elegance rather than goods carrying capacity. Wood as structural element or decoration has practically disappeared. As speeds rise, it appears that this type of car can be as fast as the equivalent saloon or faster, given the same axle ratio, and the larger side area aft may give better stability in side winds. Rear opening arrangements are far from finality. The Americans favour a rear window winding down into a hinged tail-gate, an idea tried by Humber but abandoned. The dropping tail-gate and lift-up window are rather cumbersome, and there is a trend towards a single lift-up panel, as on the Morris Oxford and Opel Rekord. Some American manufacturers, using the Goodyear Captive-Air tubeless tyre with inner safety membrane, dispense with the spare wheel on station wagons, but Opel have found a neat place for it within the contour of the rear wing, a position also utilised on their saloon. Incidentally, they make their screen pillar as a single pressing, eliminating the welds which have to be dressed and form a prolific source of poor seals and rain leakages on many cars with wrap-round windscreens.

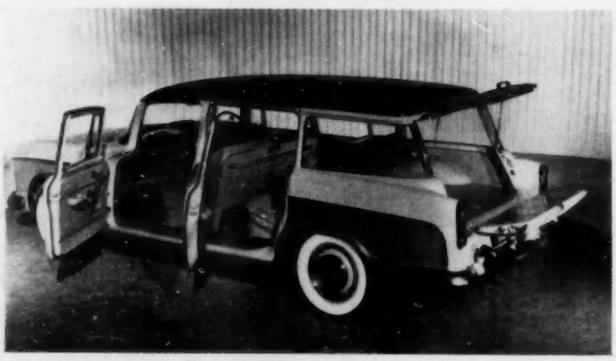


(Above) The external panels of the new Vauxhall Cresta have been designed as stress-carrying surfaces. The roof pillars are extremely slim but the glass itself contributes to the general stiffness.

(Left) An entirely different technique is employed in the Citroen DS19. Every piece of external panelling is detachable including the plastics roof—a great asset in case of damage.

AUTOMATIC TRANSMISSION

The search for an automatic transmission which will give smooth step-free changes of ratio without the cost, complication, weight and efficiency losses of American types continues, and M.I.R.A. have revealed a prototype of their hydrostatic drive, suitable for engines of about 2-litres swept volume. It is a hydraulic positive displacement drive using a vane-type pump and motor circulating oil from one to the other, combined with two planetary gear sets in a differential or shunt type transmission. The aim is to obtain the maximum range of ratios for the minimum use of hydraulics and in the worst case only about 35 per cent. of the torque is transmitted by hydraulic means. The ratio is determined by a hydraulic control valve governed by road speed and throttle opening, with a manual override. At the two limits of control valve position, one hydraulic unit is at zero delivery and unable to pass fluid, while the other, being adjusted to maximum delivery, cannot rotate since the fluid flow is blocked. Thus at the two extremes, one unit is locked stationary, and the other can spin freely. The



The station wagon is still gaining in popularity. These two examples from the Rootes group, showing the Humber Hawk (left) and the Singer Gazelle (right), emphasize that vehicles of this class can be as elegant and as comfortable as a saloon and often more stable due to the large area aft. Wood as a structural element or decoration is fast disappearing.

hydraulic pump is connected to the sun wheel in one epicyclic gear set, and the hydraulic motor is connected to the annulus of the second set. When the pump is locked, a mechanical step up of 1·4 : 1 is obtained through the planet carrier and annulus of the first gear set. When the hydraulic motor is locked, a low ratio of 3 : 1 is obtained through the sun and planet carrier of the second set. In between these extremes, both epicyclic sets transmit power. The transmission is now available to individual manufacturers to develop according to their own requirements. It is claimed that cost and weight should be comparable with those of a normal clutch and gearbox.

Standard have decided to adopt the Borg Warner transmission for the Vanguard after much development work on the Ferguson Teramala hydro-kinetic drive, but in a recent communiqué drawing attention to the fact that the Renault Transfluide drive was based on Teramala designs, Mr. Ferguson claimed that his own transmission was better than the Renault, and ready for use. Fundamentally, it is believed the Ferguson system consists in gearing down the converter, and putting a controllable free wheel behind it. This explains his claim that the gears in his system can be lighter and cheaper than those where the gears have to withstand engine torque multiplied by the converter, but it does of course introduce the problem of eliminating the impression of fuss which can be created by a fast revving engine during acceleration.

The Renault system uses a converter of relatively large diameter giving a modest conversion ratio of 2·2 : 1 and a coupling point at 2,000 r.p.m. It does eliminate the " slipping clutch " effect on initial acceleration and used in conjunction with a three-speed all-synchromesh box, with automatic clutch, gives an acceptable semi-automatic compromise. In information initially released by the works the clutch was described as " electro-magnetic." In fact, it is a normal friction clutch disengaged during gear changing by a vacuum servo piston under control of a solenoid operated by a switch in the ratio selector lever.

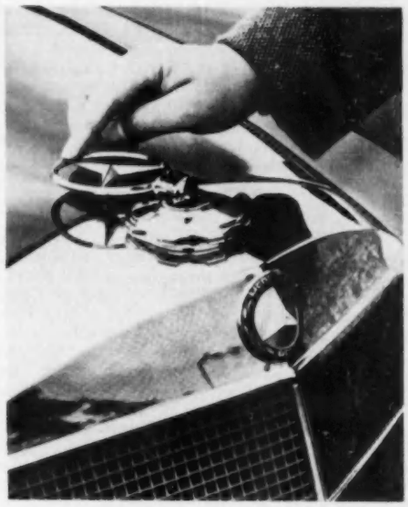
For the smallest cars, an automatic clutch will have to meet the easy-driving demand during the next few years. Ford have cleaned up the installation and operation of the Newton centrifugal clutch on the Anglia and Prefect, using a switch in the gear lever knob to control the electrically operated servo air valve without the need for pressing a separate button, and introducing an inhibitor switch on the gear selector which makes it impossible to start the engine except in neutral. There is also a simple tow-start device which brings the whole clutch into operation rather than depending on a sprag as in some other systems.

The Smiths electromagnetic powder clutch as now fitted on the Isetta is illustrated in an accompanying sketch. By building the heavy windings into the clutch housing instead of the flywheel, gear changing is speeded up, moving contacts are eliminated, and the load on synchromesh cones is reduced. In fact, it proved necessary to add a little weight to the flywheel of the single-cylinder Isetta engine in order that sufficiently smooth running could be achieved.

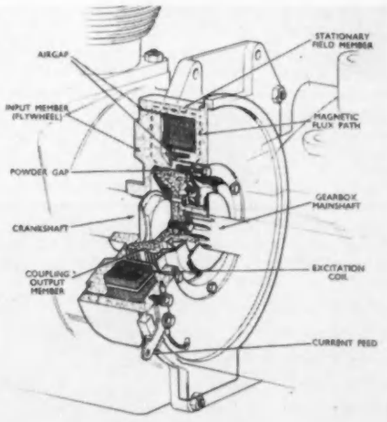
The continued rise in compression ratios (some of the 1958 American engines are operating at 11 : 1) is making it necessary to machine combustion chambers so as to ensure uniformity between cylinders, and the larger of the two Edsel engines achieves a fully machined chamber without any supplementary operations, by mounting a flat-faced cylinder head at an angle on the block, so that a wedge-section combustion chamber is bounded by the head, the cylinder bore, and a recess in the piston crown. For these high compression ratios the wedge-shaped combustion chamber seems to be ousting the hemispherical type, not only because the valve gear is simpler, but also because it provides sufficient clearance between valves and piston in a very compact space.

From America comes the Ford Mercury station wagon seating 9 passengers. The rear window rolls down into the tail-gate, thus eliminating the cumbersome lift-gate and adding open-car ventilation to closed-car protection.

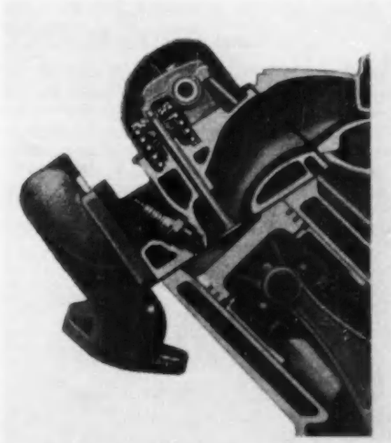
The Opel Caravan has a neat " pocket " for the spare wheel which is housed within the contour of the rear wing. The screen pillar is a single pressing, thus eliminating the need for welding—always a source of poor seals and rain leakage.



Much controversy has arisen in this country and abroad regarding the danger of car mascots in the event of collision with pedestrians. The star on this Mercedes-Benz has a coil spring in the base which allows it to fold back on impact.



Gear changing is speeded up, moving contacts eliminated and the load on synchromesh cones is reduced by building the heavy windings into the clutch housing of this Smiths electromagnetic powder clutch instead of the flywheel.



The high compression ratio on the American Ford Edsel necessitates complete machining of combustion chamber surfaces. The design permits the use of a flat-faced cylinder head without any supplementary machining operations.

Continuing **Automobile Engineering**

ROUTEMASTERS FOR COACH SERVICE

Fully-Automatic Gear Control

Following the success which has attended the decision of the London Transport Executive to introduce its new Routemaster series of vehicles on the regular London bus services, experiments are now in hand with a view to adapting these double-deck vehicles to the needs of the Executive's Green Line routes, which have hitherto been serviced mainly by single-deck coaches. An experimental vehicle, embodying Routemaster features, is now being tried out in the normal passenger-carrying service between Aldgate and Brentwood, and will later be used on other Green Line routes.

The new prototype, which has been specially designed to provide smooth riding, has been developed under the supervision of Mr. A. A. M. Durrant, C.B.E., the Executive's chief mechanical engineer, and is known as CRL.4, the initials representing Coach Routemaster Leyland. This vehicle is the third in the Routemaster series to enter public service. It is similar in its basic design to the earlier prototypes, but its mechanical units have been supplied by Leyland Motors Limited, Leyland, Lancs. The engine, which is of the Leyland 0600 9·8 litre type, normally developing 125 b.h.p. at 1,800 r.p.m., has been derated to 115 b.h.p. to meet the needs of London Transport.

The gear transmission is fully automatic, having an electro-hydraulically operated epicyclic gearbox, manipulated through a control circuit, designed and built by Self Changing Gears Limited, Coventry, to the Executive's requirements. The arrangement gives control over the second, third and fourth gears; the first and reverse gears being selected manually by the five-position gear selector lever. When the lever is placed in either second or third, that gear is engaged and remains engaged until the lever is moved; but, on placing the lever in fourth (top) gear, the full automatic characteristics of the equipment are brought to bear and gear changing up and down between the second, third and fourth gears takes place without further intervention by the driver, according to the speed of the vehicle and the load on the engine arising from the passenger load or road gradient.

Fresh air for both saloons is admitted through an aperture immediately below the front destination box and passes to the upper saloon through five diffusers in the upper front bulkhead, and to the lower saloon through two diffusers in the centre of the lower front bulkhead. The volume of air passing into the lower saloon can be regulated by a control attached to the upper of the two diffusers, but there are no fittings at present to provide air control in the upper saloon. Apart from this control, the volume of air passing into the vehicle is dependent upon the outside air velocity and the speed of the vehicle. The size and location of the diffusers have been arranged so as to keep the air velocity in the saloons at a minimum and thereby provide draught-free ventilation. Air is diffused over the inside of the front windows to provide demisting. The air can be heated when necessary.

The coach gives seating for 55 passengers, 32 on the upper and 23 on the lower deck. A novel departure from established practice is the provision of three bucket-type single seats in the lower saloon over the rear wheel arches. These seats are set at an angle of approximately 45 deg. so that all passengers may have a forward, or near-forward, view. They take the place of the conventional two facing rows of bench seats.

Another feature is the provision of lightweight luggage racks above the windows on each side of the two saloons. There is accommodation for large cases under the stairs, as well as a space to the rear of the off-side single seat to take smaller items, and the conductor's locker is placed between these two luggage spaces.

Folding platform doors of the double jack-knife pattern are provided. They are electrically-operated and are the first doors of their type which London Transport has fitted to a double-deck vehicle. Their operation will normally be effected by the conductor from controls fitted alongside, but duplicate controls are provided for the driver. An emergency release button is provided outside the vehicle in a convenient position just in front of the doors.

The bodywork of the coach, which is 27 ft. 6 in. long by 8 ft. wide, is by Eastern Coach Works Limited, and, in spite of the additional equipment, its unladen weight is well below that of the vehicles which it is expected to replace.

Fig. 1 Experimental Green Line Routemaster. The side-opening bonnet is made of glass fibre. Production models will differ from this in front appearance.

Fig. 2 The rear portion of the lower saloon, showing the skew seats, the folding doors and two of the quarter-drop windows.

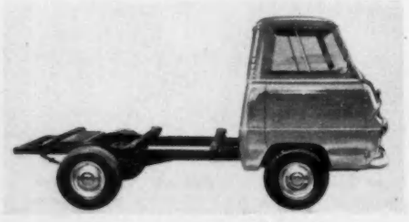
NEW SERIES OF FORD VANS

Joining the Thames Trader series of Ford commercial vehicles is a new range of 10/12 and 15 cwt. vans, chassis and estate car variants. One of the main features of interest of these new vehicles is that they employ the chassis-and-cab plus built-on body principle. Alternatively, they can be a chassis-windscreen build-up with a wide variety of bodies. The arrangement offers some advantage in the export market as it means that only the chassis need be exported.

As may be seen from the illustrations, forward control is used, the engine being mounted beside the driver and between him and his companion. The engine casing is fully insulated. To enable use in all weathers, a large heater is fitted directly in front of the engine, and the cab roof is heat insulated. The engine is the same as used in the Consul, 1703 c.c., with a compression ratio of 6·9 to 1 in the standard version for most fuels, or of 7·8 to 1 for special purposes. The gear-change lever is mounted on the steering column, and synchromesh is fitted on second and third gears. Rear axles with alternative ratios are available for both the 10/12 and 15 cwt. models.

The standard van body has a rectangular capacity of 170 cub. ft. and is designed for a low loading height. There can be a side door as well as the two rear doors. As an estate car, it can have 8 to 10 seats which may be either fixed or movable. The passenger door has an automatic folding step to give ease of entry—an aim which has been followed for all versions. Considerable attention has also been paid to the general appearance of the vehicles, there being a range of colours having the same class of finish as on the Zephyr-Zodiac range.

Specially developed for this range is a new type of Ford ball-joint independent front suspension which, in conjunction with asymmetrical semi-elliptic rear springs, gives an extremely comfortable ride and first-class stability over the most arduous routes. The front suspension uses independent coil springs with double wishbones of unequal length carrying ball-joints on which each wheel spindle pivots. Direct double-acting telescopic shock absorbers operate coaxially with the coil springs, and an anti-roll bar is incorporated. Lever-type rear shock absorbers are a standard fitting. The single-piece windscreen ensures good visibility and a turning circle of 35 ft. aids manoeuvrability.



The chassis-and-cab construction of the new range of 10/12 and 15 cwt. vehicles, allows a wide choice of bodies to be fitted.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Applications of Fluorescent Lighting," by G. V. McNeill. South East London Branch. Eltham Green School, Queenscroft-road, S.E.9. Tues., Nov. 5, 7.15 p.m.
"Under Floor Ducting," by E. J. Sutton. West London Branch. Windsor Castle Hotel, 134 King-street, W.6. Tues., Nov. 5, 7.30 p.m.
"Refrigeration," by W. Boag. North London Branch. Queen's Head Hotel, 677 Green Lanes, Harringay, N.4. Wed., Nov. 6, 7.45 p.m.
ILFORD
"Earth Leakage Protection of Domestic and Industrial Installations," by J. A. Robbins. North East London Branch. Angel Hotel, Ilford. Mon., Nov. 4, 8 p.m.
LEEDS
"Very High Frequency Radio," by H. B. Reeder. Leeds Branch. Great Northern Hotel, Leeds. Mon., Nov. 4, 7.30 p.m.
MANCHESTER
"Silicones in the Electrical Industry," by B. F. W. Hayward. Manchester Branch. Engineers' Club, Albert-square, Manchester. Wed., Nov. 6, 7 p.m.
PRESTON
"Industrial Photo-Electric Applications," by A. G. Hickman. Preston Branch. R.A.F.A. Club, East View, Preston. Wed., Nov. 6, 7.30 p.m.

Chemical Society

LONDON
Symposium on "Newer Preparative Methods in Organic Chemistry." Joint meeting with the Fine Chemicals Group of the Society of Chemical Industry. University College, Gower-street, W.C.1. Thurs., Nov. 7, 2.15 p.m. and 5 p.m.
CAMBRIDGE
"Modern Developments in Organic Chemical Industry," by Dr. R. Holroyd. Cambridge Branch. University Chemical Laboratory, Lensfield-road, Cambridge. Fri., Nov. 8, 8.30 p.m.
ST. ANDREWS
"Polymerisation at High Conversion," by Professor G. M. Burnett. St. Andrews and Dundee Branch. Chemistry Department, St. Salvator's College, St. Andrews. Fri., Nov. 8, 5.15 p.m.

Faraday Society

LONDON
"Crystal Defects, Especially Near Phase Transmission," by Professor W. Jost (of the University of Göttingen). Chemistry Department, Imperial College, South Kensington, S.W.7. Mon., Nov. 4, 5 p.m.

Illuminating Engineering Society

LONDON
"A Review of Present Architectural Thought and Trends," by H. T. Cadbury-Brown. Royal Institute of British Architects, Portland-place, W.1. Thurs., Nov. 7, 6 p.m.
CARDIFF
"Lighting in Shops and Stores," by R. L. C. Tate. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Wed., Nov. 6, 6 p.m.
EDINBURGH
"Lighting in Relation to Modern Ceilings and Roofs," by Derek Phillips. Edinburgh Centre. Y.M.C.A., 14 South St. Andrew-street, Edinburgh. Wed., Nov. 6, 6.15 p.m.
GLASGOW
"Lighting in Relation to Modern Ceilings and Roofs," by Derek Phillips. Glasgow Centre. Lighting Service Bureau of Scotland, 29 St. Vincent-place, Glasgow, C.1. Thurs., Nov. 7, 6.30 p.m.
NOTTINGHAM
Discussion on "Street Lighting." Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Thurs., Nov. 7, 6 p.m.*

Incorporated Plant Engineers

LONDON
"Lighting Installations for Industry," by W. Robinson. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Nov. 5, 7 p.m.*
EDINBURGH
"The Clean Air Act," by T. M. Ashford. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Wed., Nov. 6, 7 p.m.
GLASGOW
Brains Trust Meeting. Glasgow Branch. St. Enoch's Hotel, Glasgow. Tues., Nov. 5, 7.15 p.m.
LEICESTER
Discussion on "Training for Managerial Efficiency." Leicester Branch. Bell Hotel, Leicester. Wed., Nov. 6, 7 p.m.
PETERBOROUGH
Discussion on "Flight Testing of High-Speed Aircraft." Peterborough Branch. White Lion Hotel, Church-street, Peterborough. Tues., Nov. 5, 7.30 p.m.
SOUTHAMPTON
Brains Trust Meeting on "Road and Internal Transport and Its Associated Equipment." Southern Branch. Polygon Hotel, Southampton. Wed., Nov. 6, 7.30 p.m.

Institute of Fuel

LONDON
"The Shatter Strength of Cokes from High-Volatile Coals: The Use of Plastometer Measurements on Blends for Test-Oven Experiments," by D. W. Gillings and W. Lawson. Institution of Civil Engineers, Great George-street, S.W.1. Thurs., Nov. 7, 5.30 p.m.*
NEWCASTLE-UPON-TYNE
"Nuclear Reactors of Advanced Type," by A. Robson. North Eastern Section. King's College, Newcastle-upon-Tyne. Mon., Nov. 4, 6.30 p.m.

Institute of Marine Engineers

LONDON
"Deck and Engine Auxiliaries," by Commander D. W. Malim, R.N. (ret.). Mon., Nov. 4, 6.30 p.m.*
LIVERPOOL
"The Free Piston Engine and Its Marine Application," by P. Watson. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Mon., Nov. 4, 6 p.m.

Institute of Metals

LONDON
"Refractories," by Dr. J. White. London Local Section. Royal School of Mines, South Kensington, S.W.7. Thurs., Nov. 7, 7 p.m.
BIRMINGHAM
"Tool Steel Development," by A. P. T. Taylor Gill. Birmingham Local Section. College of Technology, Gosta Green, Birmingham. Thurs., Nov. 7, 6.30 p.m.

Institute of Packaging

GLASGOW
"Tinplate and Aluminium Containers," by N. F. Phillips. Scottish Area. More's Hotel, Glasgow, C.2. Mon., Nov. 4, 7 p.m.

Institute of Petroleum

LONDON
"Cyclical Fluctuations and Black Oil Demand: an Introduction," by G. Chandler and D. W. Lindsell. Wed., Nov. 6, 5.30 p.m.*

Institute of Physics

LONDON
Discussion on "Photoelastic Reflection Techniques," opened by Dr. H. Fessler and D. J. Haines. Stress Analysis Group. University College, Gower-street, W.C.1. Thurs., Nov. 7, 6 p.m.
MANCHESTER
"River Waves," by Professor M. J. Lighthill. Manchester Branch. Bragg Lecture Theatre, The University, Manchester, Fri., Nov. 8, 6.45 p.m.
NEWCASTLE-UPON-TYNE
"Recruitment and Training of Physicists," by N. Clarke. North Eastern Branch. King's College, Newcastle-upon-Tyne. Thurs., Nov. 7, 6.15 p.m.*

Institute of Refrigeration

LONDON
"A Review of Methods for Odour Control in Refrigerated Space," by Dr. W. Summer. Junior Institution of Engineers, Pepys House, 14 Rochester-row, S.W.1. Thurs., Nov. 7, 5.30 p.m.*

Institution of Chemical Engineers

LONDON
Ninth Hinchley Memorial Lecture: "An Education for Our Times?" by Dr. R. P. Linstead. Geological Society, Burlington House, Piccadilly, W.1. Tues., Nov. 5, 5.30 p.m.*
LEEDS
"A Statistical Approach to Catalyst Development"—part II, by N. L. Franklin and P. H. Pinchbeck. North Western Branch. Chemistry Department, The University, Leeds. Wed., Nov. 6, 7 p.m.

Institution of Civil Engineers

LONDON
Presidential Address by Sir Arthur Whitaker. Tues., Nov. 5, 5.30 p.m.*
MANCHESTER
"Employment of Contractors' Plant on Civil Engineering and Construction Works," by R. H. McGibbon and J. H. Brass. North Western Association. Engineers' Club, Albert-square, Manchester. Thurs., Nov. 7, 6.30 p.m.

Institution of Electrical Engineers

LONDON
"The Design of the Control Unit of an Electronic Digital Computer," by Dr. M. V. Wilkes, W. Renwick and Dr. D. J. Wheeler; "A Decimal Adder Using a Stored Addition Table," by M. A. Maclean and D. Aspinall; and "An Accurate Electroluminescent Graphical Output Unit for a Digital Computer," by Dr. T. Kilburn, Dr. G. R. Hoffman and R. E. Hayes. Measurement and Control Section. Tues., Nov. 5, 5.30 p.m.*
Discussion of the H.M.S.O. Report on "The Supply and Training of Teachers for Technical Colleges," opened by Dr. Willis Jackson. Thurs., Nov. 7, 5.30 p.m.*
BIRMINGHAM
Film "Construction of the Super Grid," introduced by H. S. Davidson. South Midland Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., Nov. 4, 6 p.m.*
DERBY
"Electricity in Modern Commercial Horticulture," by C. A. Cameron Brown and A. W. Gray. East Midland Centre. East Midlands Electricity Board's Service Centre, Derby. Tues., Nov. 5, 6.30 p.m.*
LIVERPOOL
"A Standard Gas Turbine to Burn a Variety of Fuels," by G. B. R. Feilden, J. D. Thorn and M. J. Kempet. Mersey and North Wales Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Thurs., Nov. 7, 6 p.m.
MANCHESTER
"138 kV Submarine Power Cable Interconnection Between the Mainland of British Columbia and Vancouver Island," by Dr. T. Ingledow, and others. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Nov. 5, 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Electric Heat Treatment Furnaces," by J. W. Payne. North East Branch. Northern Architectural Association, 6, Higham-place, Newcastle-upon-Tyne. Mon., Nov. 4, 7.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"The Geometry of the Job," by W. Heigh. Tues, Nov. 5, 6.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Noise in Fans, with Particular Reference to the Axial-Flow Fan," by B. B. Daly. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Nov. 7, 6 p.m.*
LEICESTER
"Floor Warming as a Means of Space Heating (Electric Heating)," by Thomas F. Cadman. East Midland Branch. College of Technology, Leicester. Wed., Nov. 6, 6.30 p.m.

Institution of Highway Engineers

NORWICH
"Tunnelling," by J. Kell. East Anglia Branch. Assembly House, Norwich. Tues., Nov. 5, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "The Breakage of Cutting Tools." Industrial Administration and Engineering Production Group. Wed., Nov. 6, 6.45 p.m.*
"Vacuum Techniques in the Atomic Energy Industry," by Dr. H. Kronberger. In conjunction with the British Nuclear Energy Conference. Fri., Nov. 8, 6 p.m.*
GLASGOW
"Pressure Vessel Design," by Dr. W. B. Carlson. Scottish Branch. Royal College of Science and Technology, Glasgow Thurs., Nov. 7, 7.30 p.m.
LEICESTER
"Matters for Management," by Dr. R. Beeching. East Midlands Branch. City Boys' School, Humberstone Gate, Leicester. Wed., Nov. 6, 7.15 p.m.
LUTON
"Principles and Applications of Spark Machining," by D. W. Rudorff. Eastern Branch. Town Hall, Luton. Thurs., Nov. 7, 7.30 p.m.
NEWCASTLE-UPON-TYNE
"Operational Research," by Stafford Beer. North Eastern Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Nov. 4, 6 p.m.

Institution of Production Engineers

IPSWICH
Chairman's Address on "Developments in Machine Tool Drive Units," by L. A. Childs. Ipswich and Colchester Section. Golden Lion Hotel, Cornhill, Colchester. Fri., Nov. 8, 7.30 p.m.
LOUGHBOROUGH
"Fusion Welding of Ferrous Materials," by P. H. R. Lane. Leicester Section. Schofield Building, Loughborough Technical College, Loughborough. Thurs., Nov. 7, 7 p.m.
NOTTINGHAM
Film "Manufacture of Tubing," with discussion. Nottingham Section. Victoria Station Hotel, Nottingham. Wed., Nov. 6, 7 p.m.

Junior Institution of Engineers

LONDON
"Television," by T. M. C. Lance. Fri., Nov. 8, 7 p.m.*

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Nuclear Power for the Propulsion of Merchant Ships," by Dr. S. Livingston Smith and Dr. J. E. Richards. Literary and Philosophical Society's Hall, Newcastle-upon-Tyne. Mon., Nov. 4, 6.15 p.m.*

Physical Society

LONDON
"Colour and Geology," by E. A. Jobbins; and "Gems," by B. W. Anderson. Colour Group. Institute of Ophthalmology, Judd-street, W.C.1. Wed., Nov. 6, 3.30 p.m.

Reinforced Concrete Association

LIVERPOOL
"Concrete Additives," by M. Sandall. North Western Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Nov. 6, 6.30 p.m.*
MANCHESTER
"Concrete Additives," by M. Sandall. North Western Branch. College of Technology, Sackville-street, Manchester. Tues., Nov. 5, 6.45 p.m.*

Royal Institution

LONDON
"New Ways with Large Molecules," by Dr. Geoffrey Gee. Fri., Nov. 8, 9 p.m.

Society of Engineers

LONDON
"Hydraulics in Industry," by R. H. Bound. Geological Society, Burlington House, Piccadilly, W.1. Mon., Nov. 4, 5.30 p.m.*

Society of Instrument Technology

BIRMINGHAM
"The Art and Craft of Instrumentation," by J. K. Burkitt. Midland Section. Regent House, St. Phillip's-place, Colmore-row, Birmingham. Fri., Nov. 8, 7 p.m.

Women's Engineering Society

LONDON
"Meteorological Aspects of the International Geophysical Year, and the Problems of a Polar Meteorologist," by D. Limbert. Central Electricity Authority's Headquarters, Winsley-street, Oxford-circus, W.1. Wed., Nov. 6, 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Faraday Society, 6 Gray's Inn-square, London, W.C.1. (CHAncery 8101.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, 76 Mark-lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Packaging. Apply to Mr. H. Williams, 80 Lancaster-avenue, London, S.E.27. (GIPsy Hill 4859.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (SLOane 9806.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria-street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Society of Engineers, 17 Victoria-street, London, S.W.1. (ABBey 7244.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)
Women's Engineering Society, 25 Foubert's-place, London, W.1. (GERrard 5212.)

The Human Element

Building in Cloud Cuckoo Land?

The 18 building unions have come together to demand the 40-hour week, a five-day week and a wage increase—in short, a fairly ambitious " package " deal with the employers. It is not likely that the demand will meet with much sympathy from the latter especially since the building operatives had a useful increase in pay last May. To some extent the demand has been stimulated by what are called the political consequences of the higher Bank rate. The shorter working week is added now because, according to the union representatives, the housing shortage since the war made it imperative not to limit output. This is a not so skilful bid to get public sympathy.

The consequences of Bank rate may be various. It will not be surprising if one of them, however, is a reduction in the volume of building —a volume which is already losing something of its impetus, judging from the latest Board of Trade figures of building plans approved and the reactions of those public authorities which have large housing programmes on hand. The building societies too are becoming shy lenders. If all this works out to a logical conclusion before other forces get to work to offset the trend, the case for the 40-hour week will rest on a shortage of work for union members; it will then be a matter of something more inexorable than the negotiating prowess of the builders to stop the operatives getting what they ask.

Rail Spearhead

The stage is being set for next year's struggle between unions and employers, which will start any time between January and March. In the background will be the Government's deflationary policy and possible unemployment. Most unions are likely therefore to put forward claims which involve the improvement of working conditions rather than large increases in wages.

Many trade union leaders are known to oppose large wage claims on the ground that they threaten British industry's ability to export. A different view is taken, however, of demands for shorter hours and longer holidays. This, the unions feel, will help to maintain labour's bargaining power by re-introducing a shortage (or removing a surplus). The remark made last week by Mr. W. J. Carron, the national president of the A.E.U. (who was elected against strong Communist opposition), that he hoped the engineering employers would recognise that a 40-hour week was " absolutely inevitable," coupled with veiled threats of strike action, was for the benefit of employers whose minds are understood to be already made up.

The N.U.R., on the other hand, have just put in claims for " a substantial increase in pay " coupled with shorter hours and a third week of paid holidays. The cost of the latter alone would be over £5 million a year. The wage claim is left vague, but is unlikely to be less than that for a 10 per cent. increase put in recently by A.S.L.E.F. In about a month's time the British Transport Commission will reply and will almost certainly reject the major part of the claims. Failing an agreed settlement, therefore, the Commission will have to decide to meet the the union's minimum terms or face a strike. The plain fact is that the Government can play a decisive part, either by instructing the Commission to act in accordance with official policy or by controlling the borrowing of money and thus preventing any major increase in total expenditure.

Government Intentions

The Government have been at great pains to avoid creating the impression that their professed toughness in fighting inflation will be directed mainly against the trade unions. Attempting to influence the Ipswich voters last week, Lord Hailsham promised there would be " no war on the workers ": " there will be no such thing in the ordinary sense as a wage freeze. There will be no attempt to prevent the operation of the established processes of free collective bargaining and arbitration." But, Lord Hailsham said, and this is the core of Government policy, " we are not going to finance further increases in expenditure." This means that if British Railways decide to pay out more on wages they will have to economise on something else.

When Mr. Thorneycroft, Chancellor of the Exchequer, met trade union leaders last week he told them that further wage increases would lead to lessened confidence in the pound and a consequent possible reduction in living standards. He was taking part in the meeting of the National Advisory Council at the invitation of their chairman, Mr. Iain MacLeod, Minister of Labour. Like other Government Ministers, Mr. Thorneycroft emphasised that the nation was threatened by inflation through a runaway boom, not the reverse. Investment in the nationalised industries would not be cut—only in so far as it was made necessary by increases in their wage bills.

These statements show clearly enough what the Government intend to do. They firmly believe the enemy is a boom, not a slump, and that inflation must be controlled. At the same time they realise that they must avoid industrial conflict. But it is difficult to conceive that the Government's deflationary policy, which must if successful create some unemployment, will be conducive to the " understanding, support and sympathy of industry and the people " which Mr. MacLeod is seeking.

F.B.I. on Technical Education

The Second National Conference between Industry and the Technical Colleges organised under the auspices of the Education Committee of the Federation of British Industries was held in May of this year and its proceedings were published in booklet form last week (price 5*s*.). This conference follows a first of its kind held in May, 1954. Conferences of this kind are a useful and highly necessary way of keeping a vital subject in front of public attention in a democracy. If ever this country is to develop its technical education on the scale necessary to hold its position in technology in the second half of the Twentieth Century it will have to talk itself into it—in the best sense of that word.

Subjects covered included a survey of technical education, technical education as an economic necessity, the future of sandwich courses and training teachers. It was formally opened by Lord Hailsham, then the Minister of Education.

One of the most interesting features of the conference was the emphasis laid on broadening educational experience for the technical man. A paper by Dr. P. F. R. Venables led off this discussion and it is clear that there is a good deal of agreement among technical educationists and those industrial leaders who are interested in the subject that there should be a broadening of educational syllabuses at key stages in training. How to do it, when and to what extent remains the problem.

Boilermakers Try the Stopwatch

In the United States the boilermakers union, along with that for the electrical workers, has recently taken part in a time and motion study course. It was held in Wisconsin under the auspices of the A.F.L.-C.I.O. Department of Research. The course lasted a week and was attended by managers as well as union leaders.

Practical flavour was given to the programme by actual time study work by those attending (an exercise which most laymen learn to tackle in a spirit of humility). A standard process was timed and then a variation worked out which was made the occasion for a mock union protest. This was taken through the various stages of negotiation by all concerned.

This kind of thing is broadening both for labour and management. It forces the participants to see the other fellow's point of view as it evolves. Such is the way to intelligent management-labour relations, though not perhaps the way of militancy. The day may even come when the sign of union orthodoxy is the stop watch rather than the open-necked shirt.

When Black can be White

The curtain raiser to what may become a very serious situation should unemployment increase is to be a special meeting of coloured workers employed on the railways to discuss " mutual problems." The meeting has been called for November 18 by the London District Council of the N.U.R. Mr. S. D. Hoskins, chairman of the Council, has vigorously denied that this meeting of coloured railwaymen was to deal with the colour bar. " So far as we are concerned," he said, " there is no colour bar." There is, however, " a certain amount of colour prejudice " on both sides. The meeting's object, according to Mr. Hoskins, was to show the coloured workers " that we welcome them, regard them as fellow workers, understand their problems and want them to understand ours."

These are admirable sentiments, and there is doubtless a lot of scope for teaching coloured workers the elementary principles and rules of trade unionism. The coloured workers' chief difficulties, said Mr. Hoskins, arose " from ignorance of trade union working." In the hard struggle that may be expected if the wage claims are pressed forward, the N.U.R. must remove any weaknesses among themselves. The colonial element are felt to be particularly vulnerable, hence the N.U.R.'s wish to teach trade unionism at this late stage in the employment of coloured people by British Railways. The " helping hand " extended to them by the London district council of the N.U.R. will, without much doubt, prove to be a firm guiding hand into the camp of militant trade unionism.

The Mighty Atom

Great oaks do from little acorns spring. When the acorns are rumour or inaccurate information the oaks are particularly large, especially if they have a jungle setting. It would seem that all this is especially true of nuclear warfare.

According to a War Office announcement last week, an officer in Malaya has been studying, among other things, the theoretical behaviour of tactical nuclear weapons in jungle conditions (one would have thought that one subject of this sort would have been enough for most intellects, but not the British Army). These were paper studies. The officer has now been posted elsewhere leaving a vacancy which the Press has managed to blow up into a demand for 50 vacancies for nuclear scientists in Malaya. Small wonder that the War Office has had to deny that these paper studies denote any intention to introduce nuclear weapons into Malaya.

From 50 vacancies for nuclear specialists, rumour and imagination could easily have developed the harassed officer and his paper studies into all-out atomic war on the Chinese in a matter of days. It would seem that the atom has found more ways than one of distorting our sense of proportion. Through all the maze however it is possible to discern the unruffled routine of the British Army. The officer's turn had probably come for a posting—and so much the worse for the paper studies or anything else to do with the atom. And so much the better for our sense of proportion.

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